Argonne NATIONAL LABORATORY

ANL-13/02

Site Environmental Report

for Calendar Year 2012

Environment, Safety, and Quality Assurance Division

ANL-13/02

Argonne National Laboratory Site Environmental Report for Calendar Year 2012

Preceding Report in This Series: ANL-12/02

by
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This Site Environmental Report (SER) was prepared by the Environment, Safety, and Quality Assurance (ESQ) Division at Argonne National Laboratory (Argonne) for the U.S. Department of Energy (DOE). The main authors are pictured to the right. The results of the environmental monitoring program and an assessment of the impact of site operations on the environment and the public are presented in this publication. This SER is available on the Internet at http://www.anl.gov/community/environmental-protection.

The majority of the figures and tables were prepared by Jennifer Tucker of the Data Management Team. Some figures, however, were prepared by Hal Greenwood of the Ecological and Geographical Sciences Section of Argonne's Environmental Science Division (EVS). Support to prepare this report was provided by Terri Schneider (ESQ). The members of the Environmental Protection group are shown in the photograph at the beginning of Chapter 1. Sample collection and field measurements were conducted by the following members of the ESQ Environmental Monitoring Group:

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A NOTE FROM THE AUTHORS

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The Business and Technical Communications group of Argonne's Communications, Education, and Public Affairs Division (CEP) provided editorial and document processing services. Katherine Obmascik edited the document. Linda Graf and Lorenza Salinas supplied document processing and preparation.

CEP's Wes Agresta took the photographs in this report and Sue Cottrill and Michele Nelson prepared the cover. The cover depicts pictures of the fallow deer, an unofficial symbol for Argonne. This year, it appears that the fallow deer will soon be gone from the Argonne site. It is thought that disease and predators have collapsed the herd. They will truly be missed.

This report was printed by John Schneider and Mike Vaught, under the direction of Gary Weidner, members of CEP's Creative Services & Production group.

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ACHP	Advisory Council for Historic Preservation
ACM	Asbestos-Containing Material
AEA	Atomic Energy Act of 1954
AGHCF	Alpha Gamma Hot Cell Facility
ALARA	As Low As Reasonably Achievable
AOC	Area of Concern
APES	Argonne Property Excess System
APS	Advanced Photon Source
Argonne	Argonne National Laboratory
ASO	Argonne Site Office
ATLAS	Argonne Tandem Linac Accelerating System
BAT	Best Available Technology
BCG	Biota Concentration Guide
BOD_5	Biochemical Oxygen Demand
CAA	Clean Air Act
CAAPP	Clean Air Act Permit Program
CAP-88	Clean Air Act Assessment Package-1988
CAS	Chemical Abstracts Service
CCA	Compliance Commitment Agreement
CEDE	Committed Effective Dose Equivalent
CEP	Communications, Education & Public Affairs
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
CFR	*Code of Federal Regulations*
CH	Contact Handled
CLP	Contract Laboratory Program
CNM	Center for Nanoscale Materials
CO	Carbon Monoxide
CoC	Contaminants of Concern
COD	Chemical Oxygen Demand
COE	U.S. Army Corps of Engineers
CP-5	Chicago Pile-Five
CRMP	Cultural Resources Management Plan
CWA	Clean Water Act
CY	Calendar Year
D&D	Decontamination and Decommissioning
DCA	1,1-Dichloroethane
DCS	Derived Concentration Standard
DMR	Discharge Monitoring Report
DMR-QA	Discharge Monitoring Report–Quality Assurance Program
DOE	U.S. Department of Energy
DOE-ASO	DOE Argonne Site Office
DOE-HQ	DOE Headquarters
EA	Environmental Assessment
EHS	Extremely Hazardous Substance
EIS	Environmental Impact Statement

ACRONYMS

EMS	Environmental Management System
ENE	East-Northeast
EO	Executive Order
EPA	U.S. Environmental Protection Agency
EPCRA	Emergency Planning and Community Right-to-Know Act
ESA	Endangered Species Act of 1973
ESH	Environment, Safety, and Health
ESQ	Environment, Safety, and Quality Assurance Division
ESQ-AS	ESQ-Analytical Services
EVS	Environmental Science Division
FELIX	Fusion Electromagnetic Induction Experiment
FFCA	Federal Facility Compliance Act of 1992
FMS	Facilities Management and Services
FY	Fiscal Year
GHG	Greenhouse Gas
GMZ	Groundwater Management Zone
GQS	Groundwater Quality Standard
GRO	Groundwater Remediation Objective
GSA	U.S. General Services Administration
HAP	Hazardous Air Pollutant
HEPA	High-Efficiency Particulate Air
HPSB	High Performance and Sustainable Buildings
HSWA	Hazardous and Solid Waste Amendments of 1984
HTRL	Howard T. Ricketts Laboratory
IAC	*Illinois Administrative Code*
ICRP	International Commission on Radiological Protection
IDNS	Illinois Department of Nuclear Safety
IDPH	Illinois Department of Public Health
IEPA	Illinois Environmental Protection Agency
IHPA	Illinois Historic Preservation Agency
IPNS	Intense Pulsed Neutron Source
ISMS	Integrated Safety Management System
ISO	International Organization for Standardization
LEED	Leadership in Energy and Environmental Design
LEPC	Local Emergency Planning Committee
Linac	Linear Accelerator
LLRW	Low-Level Radioactive Waste
LMS	Laboratory Management System
LTS	Long-Term Stewardship
LWTP	Laboratory Wastewater Treatment Plant
MACE	Melt Attack and Coolability Experiment
MAPEP	Mixed Analyte Performance Evaluation Program
MDL	Materials Design Laboratory
MSDS	Material Safety Data Sheet
MW	Mixed Waste
MY	Model Year

NAICS	North American Industry Classification System
NBL	New Brunswick Laboratory
NCRP	National Council on Radiation Protection & Measurements
NEPA	National Environmental Policy Act of 1969
NESHAP	National Emission Standards for Hazardous Air Pollutants
NFA	No Further Action
NHPA	National Historic Preservation Act of 1966
NIST	National Institute of Standards and Technology
NNSS	Nevada National Security Site
NPDES	National Pollutant Discharge Elimination System
NPL	National Priority List
NRC	National Response Center
NRC	U.S. Nuclear Regulatory Commission
NRHP	*National Register of Historic Places*
NTS	Nevada Test Site
ORPS	Occurrence Reporting Processing System
OSHA	Occupational Safety and Health Administration
P2	Pollution Prevention
PA	Programmatic Agreement
PBT	Persistent, Bioaccumulative Toxic
PCs	Personal Computers
PCB	Polychlorinated Biphenyl
PCE	Tetrachloroethene
PF	Particulate Filter
POL	Policy
PM	Particulate Matter
PMA	Performance Management and Assurance
PPOA	Pollution Prevention Opportunity Assessment
PQL	Practical Quantitation Limit
PSTP	Proposed Site Treatment Plan
PVC	Polyvinyl Chloride
QA	Quality Assurance
QC	Quality Control
R&D	Research and Development
RCRA	Resource Conservation and Recovery Act of 1976
RESL	Radiological and Environmental Sciences Laboratory
RFI	RCRA Facility Investigation
RH	Remote Handled
RQ	Reportable Quantity
RWSF	Radioactive Waste Storage Facility
SARA	Superfund Amendments and Reauthorization Act
SCADA	Supervisory Control and Data Acquisition
SDWA	Safe Drinking Water Act of 1974
SER	Site Environmental Report
SERC	State Emergency Response Commission
SHPO	State Historic Preservation Office

SIC	Standard Industry Classification
SIP	State Implementation Plan
SME	Subject Matter Expert
SOP	Standard Operating Procedure
SPCC	Spill Prevention Control and Countermeasures
SVOC	Semivolatile Organic Compound
SWMU	Solid Waste Management Unit
SWPPP	Stormwater Pollution Prevention Plan
SWTP	Sanitary Wastewater Treatment Plant
TACO	Tiered Approach to Corrective Action Objectives
TCA	1,1,1-Trichloroethane
TCE	Trichloroethene
TCS	Theory and Computing Sciences
TDS	Total Dissolved Solids
THMs	Trihalomethanes
TLD	Thermoluminescent Dosimeter
TOC	Total Organic Carbon
TOX	Total Organic Halogens
TRC	Total Residual Chlorine
TRI	Toxic Release Inventory
TRU	Transuranic Waste
TSCA	Toxic Substances Control Act
TSS	Total Suspended Solids
USFWS	U.S. Fish and Wildlife Service
UST	Underground Storage Tank
VN	Violation Notice
VOC	Volatile Organic Compound
VOM	Volatile Organic Material
WIPP	Waste Isolation Pilot Plant
WM	Waste Minimization
WMO	Waste Management Operations
WP&C	Work Planning and Control
WQS	Water Quality Standard
WTP	Wastewater Treatment Plant
ZPR	Zero Power Reactor

ABSTRACT

This report discusses the status and the accomplishments of the environmental protection program at Argonne National Laboratory for calendar year 2012. The status of Argonne environmental protection activities with respect to compliance with the various laws and regulations is discussed, along with environmental management, sustainability efforts, environmental corrective actions, and habitat restoration. To evaluate the effects of Argonne operations on the environment, samples of environmental media collected on the site, at the site boundary, and off the Argonne site were analyzed and compared with applicable guidelines and standards. A variety of radionuclides were measured in air, surface water, on-site groundwater, and bottom sediment samples. In addition, chemical constituents in surface water, groundwater, and Argonne effluent water were analyzed. External penetrating radiation doses were measured, and the potential for radiation exposure to off-site population groups was estimated. Results are interpreted in terms of the origin of the radioactive and chemical substances (i.e., natural, Argonne, and other) and are compared with applicable standards intended to protect human health and the environment. A U.S. Department of Energy (DOE) dose calculation methodology, based on International Commission on Radiological Protection (ICRP) recommendations and the U.S. Environmental Protection Agency's (EPA) CAP-88 Version 3 computer code, was used in preparing this report.

1. INTRODUCTION

1.1. General Background Information

This annual report for calendar year 2012 of the Argonne National Laboratory (Argonne) environmental protection program was prepared to inform the U.S. Department of Energy (DOE), environmental agencies, and the public about the levels of radioactive and chemical pollutants in the vicinity of Argonne as well as the amounts, if any, added to the environment by Argonne operations. It also summarizes the compliance of Argonne operations with applicable environmental laws and regulations and highlights significant accomplishments and issues related to environmental protection, sustainability, and remediation. The report was prepared in accordance with the guidelines of DOE Order 436.1[1] and 231.1B[2] and supplemental DOE guidance.

Argonne is managed by UChicago Argonne, LLC, for the U.S. Department of Energy's Office of Science. Argonne is a DOE research and development (R&D) laboratory. Research at Argonne centers around three principal areas: Energy, Biological and Environmental Systems, and National Security. Argonne conducts an environmental surveillance program on and near the site to determine the identity, magnitude, and origin of radioactive and chemical substances in the environment. Monitoring of releases of such materials to the environment from Argonne operations is performed to verify the adequacy of the site's pollution control systems.

The principal radiological facilities at Argonne are the Advanced Photon Source (APS), a superconducting heavy-ion linear accelerator (Argonne Tandem Linac Accelerating System [ATLAS]), a 22-MeV pulsed electron linac, several other charged-particle accelerators (principally of the Van de Graaff and Dynamitron types), and other chemical and metallurgical laboratories. The principal remaining nuclear facilities at Argonne are the Alpha Gamma Hot Cell Facility (AGHCF), the Waste Management Operations (WMO) Facility, and the Radioactive Waste Storage Facility (RWST). These nuclear facilities are non-reactor facilities and they involve material handling, management, storage, and disposition. The DOE New Brunswick Laboratory (NBL), a plutonium and uranium measurements and analytical chemistry laboratory, and the University of Chicago's Howard T. Ricketts Regional Biocontainment Laboratory, a state-of-the-art biocontainment facility intended to study infectious diseases, are also located on the Argonne site.

The principal non-nuclear activities at Argonne that could potentially have measurable impacts on the environment include the use of coal-fired Boiler No. 5 and the discharge of wastewater from various sources.

1.2. Description of Site

Argonne occupies the central 607 ha (1,500 acres) of a 1,514-ha (3,740-acre) tract in DuPage County. The site is 43 km (27 mi) southwest of downtown Chicago and 39 km (24 mi) west of Lake Michigan. It is north of the Des Plaines River Valley, south of Interstate

Highway 55 (I-55), and west of Illinois Highway 83. Figures 1.1 and 1.2 are maps of the site and the surrounding areas that show some of the sampling locations associated with the monitoring program. Much of the 907-ha (2,240-acre) Waterfall Glen Forest Preserve surrounding the site was part of the Argonne site before it was deeded to the DuPage County Forest Preserve District in 1973 for use as a public recreational area, nature preserve, and demonstration forest. In this report, facilities and some sampling locations are identified by the alpha-numeric row and column designations in Figure 1.1, to facilitate identification of their locations.

The terrain of Argonne is gently rolling, partially wooded, former prairie and farmland. The grounds contain a number of small ponds and streams. The principal stream is Sawmill Creek, which runs through the site in a southerly direction and enters the Des Plaines River about 2.1 km (1.3 mi) southeast of the center of the site. The land is drained primarily by Sawmill Creek, although the extreme southern portion drains directly into the Des Plaines River, which flows along the southern boundary of the forest preserve. This river flows southwest until it joins the Kankakee River about 48 km (30 mi) southwest of Argonne to form the Illinois River.

The largest topographical feature of the area is the Des Plaines River Valley, which is about 1.6 km (1 mi) wide. This valley contains the river, the Chicago Sanitary and Ship Canal, and the Illinois and Michigan Canal. The elevation of the channel surface of these waterways is 180 m (578 ft) above sea level. The bluffs that form the southern border of the site rise from the river channel at slope angles of 15 to 60° and reach an average elevation of 200 m (650 ft) above sea level at the top. The land then slopes gradually upward and reaches the average site elevation of 220 m (725 ft) above sea level at 915 m (3,000 ft) from the bluffs. Several large ravines, oriented in a north-south direction, are located in the southern portion of the site. The bluffs and ravines generally are forested with mature deciduous trees. The remaining portion of the site changes in elevation by no more than 7.6 m (25 ft) in a horizontal distance of 150 m (500 ft).

1.3. Population

The area around Argonne has experienced significant population growth in the past 40 years as large areas of farmland have been converted into housing. Table 1.1 gives the directional and annular 80-km (50-mi) population distribution for the area, which is used to derive the population dose calculations presented later in this report. The population distribution, centered on the former Intense Pulsed Neutron Source (IPNS) (Location 9J in Figure 1.1), was prepared by the Risk Assessment and Safety Evaluation Group of the Environmental Science Division at Argonne and represents projections based on 2010 census data.

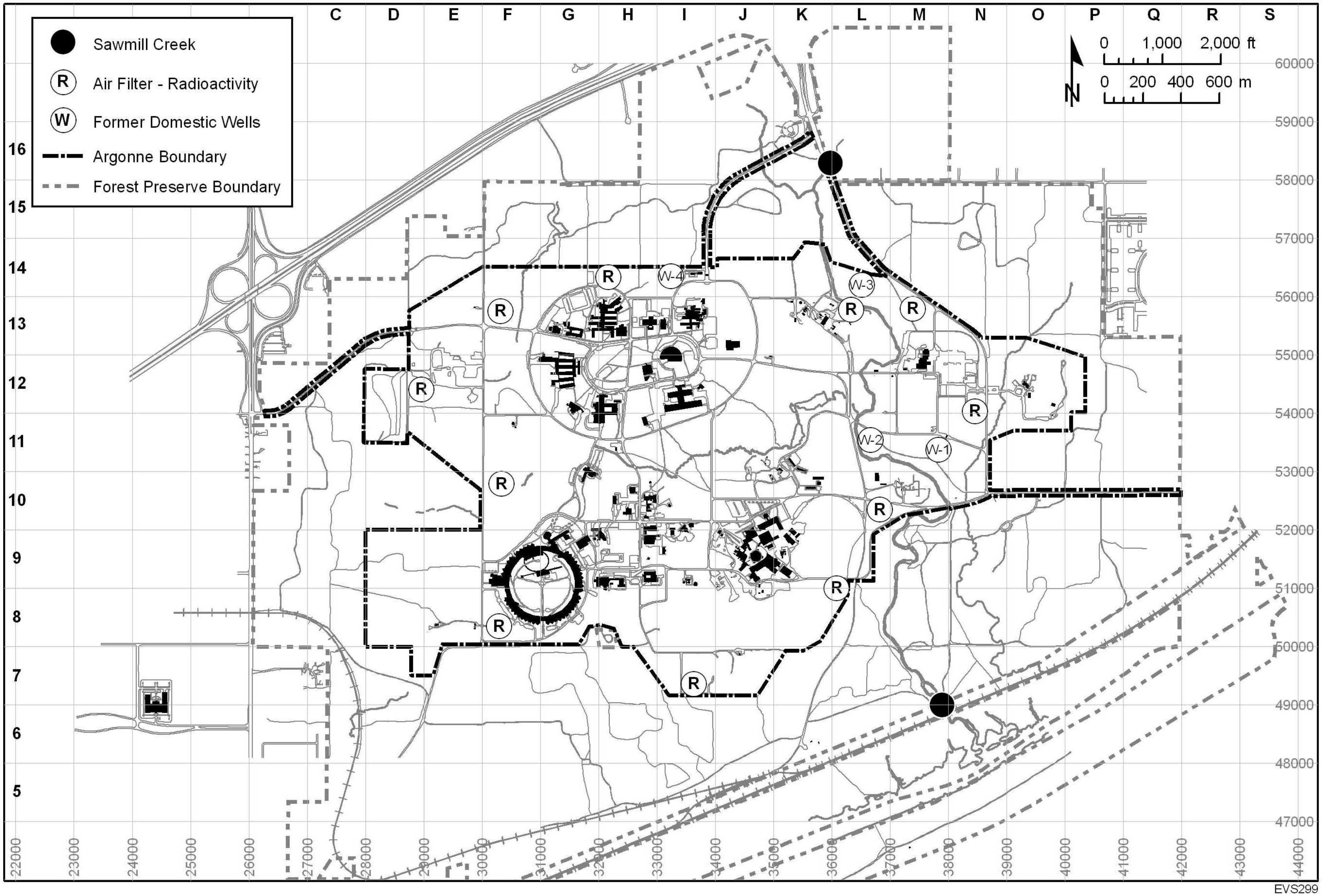


FIGURE 1.1 Sampling Locations at Argonne National Laboratory

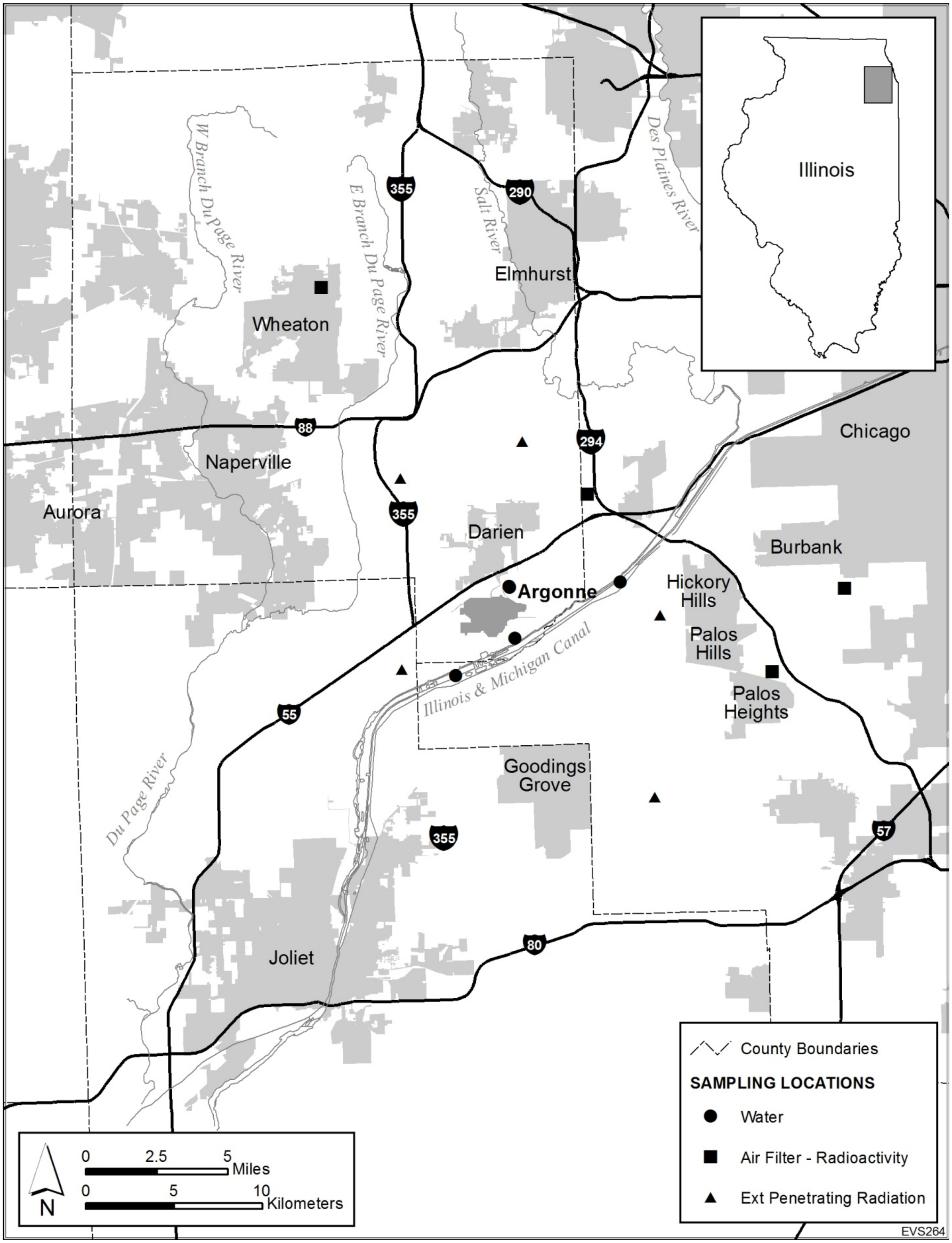


FIGURE 1.2 Sampling Locations Near Argonne National Laboratory

TABLE 1.1

Population Distribution in the Vicinity of Argonne, 2010

	Miles[a]									
Direction	0–1	1–2	2–3	3–4	4–5	5–10	10–20	20–30	30–40	40–50
N	0	814	2,647	5,953	8,811	47,617	184,007	348,667	237,929	336,788
NNW	0	1,053	2,735	5,383	8,332	35,772	212,792	278,647	199,412	146,461
NW	0	1,092	2,638	5,714	9,123	46,482	84,338	146,561	44,056	27,580
WNW	0	768	2,738	5,856	6,031	45,203	192,169	58,475	11,569	66,491
W	0	318	2,052	7,193	9,472	50,827	140,213	52,538	23,029	5,198
WSW	0	318	510	662	2,253	25,958	49,093	11,911	11,928	14,579
SW	0	411	1,204	976	662	21,598	115,610	26,180	18,655	6,718
SSW	0	351	1,990	1,943	1,675	21,781	90,801	12,734	18,941	9,749
S	0	336	2,939	2,097	1,462	12,357	42,605	6,929	41,190	34,052
SSE	0	334	877	1,086	1,736	21,533	59,663	11,688	22,794	15,084
SE	0	330	565	819	1,050	25,810	141,992	117,915	43,194	21,645
ESE	0	323	565	751	569	19,495	184,116	288,903	217,028	104,928
E	0	318	775	646	535	42,504	414,584	194,147	12,502	29,193
ENE	0	318	1,164	1,830	2,165	34,865	576,674	215,923	0	0
NE	0	524	1,917	1,895	1,947	39,283	655,856	976,951	0	0
NNE	0	688	2,670	6,223	5,763	45,598	297,144	502,090	102,749	7,614
Totals	0	8,295	27,986	49,028	61,587	536,682	3,441,657	3,250,258	1,004,974	826,080
Cumulative totals[b]	0	8,295	36,281	85,310	146,896	683,578	4,125,236	7,375,493	8,380,467	9,206,547

[a] To convert from miles to kilometers, multiply by 1.6.

[b] Cumulative totals = the total of this sector plus the totals of all previous sectors.

1.4. Climatology

The climate of the area is representative of the upper Mississippi Valley, as moderated by Lake Michigan. The most important meteorological parameters for the purposes of this report are wind direction, wind speed, temperature, and precipitation. Historic wind data were used to select air sampling locations. Data from the current year were used to calculate radiation doses from air emissions. Temperature and precipitation data are useful in interpreting some of the monitoring results. The 2012 data were obtained from the on-site Argonne meteorological station. The average wind direction for 2012 is consistent with the long-term average wind direction, which usually varies from the west to the south, but with a significant northeast component.

Table 1.2 gives 2012 precipitation and temperature data taken at 10 m (32.81 ft). The monthly precipitation data for 2012 was below the Argonne historical average in every month of the year except four (January, May, August, and October). The 2012 annual precipitation total was 21 cm (8.3 in) below the Argonne historical average. The 2012 monthly average temperature exceeded or was equal to the long-term monthly average in every month except October and November. The 2012 annual temperature was 2°C higher than the long-term monthly average. The climatology information was provided by the Atmospheric Science and Climate Research Section of the Environmental Science (EVS) Division.

TABLE 1.2

Argonne Weather Summary, 2012

	Precipitation (cm)			Temperature (°C)	
Month	Argonne 2012	Argonne Historical[a]		Argonne 2012	Argonne Historical[a]
January	4.97	4.56		–1.4	–4.5
February	3.08	4.45		–0.2	–2.3
March	4.18	6.41		11.6	3.5
April	7.12	8.55		9.9	9.6
May	11.64	9.94		18.2	15.3
June	3.13	9.46		22.5	20.9
July	7.64	10.79		26.7	23.3
August	13.06	10.81		22.5	22.3
September	3.37	8.62		18.1	18.1
October	8.90	8.32		10.3	11.5
November	2.99	8.07		4.6	4.7
December	4.16	5.40		1.9	–2.6
Total	74.24	95.38	Monthly Average	12.1	10.0

[a] Averages were obtained from the Argonne meteorological tower by using data from the last 30 years (1983–2012).

1.5. Geology

The geology of the Argonne area consists of about 30 m (100 ft) of glacial drift on top of nearly horizontal bedrock consisting of Niagaran and Alexandrian dolomite underlain by shale and older dolomites and sandstones of Ordovician and Cambrian age. The glacial drift sequence is composed of the Wadsworth and Lemont formations. Both are dominated by fine-grained drift units but also contain sandy, gravelly, or silty interbeds. Niagaran and Alexandrian dolomite is approximately 60 m (200 ft) thick but has an irregular, eroded upper surface.

The southern boundary of Argonne follows the bluff of a broad valley, which is now occupied by the Des Plaines River and the Chicago Sanitary and Ship Canal. This valley was carved by waters flowing out of the glacial Lake Michigan about 11,000 to 14,000 years ago. The soils on the site were derived from glacial drift over the past 12,000 years and are primarily of the Morley series, that is, moderately well-drained upland soils with a slope ranging from 2 to 20%. The surface layer is a dark grayish-brown silt loam, the subsoil is a brown silty clay, and the underlying material is a silty clay loam glacial drift. Morley soils have a relatively low organic content in the surface layer, moderately slow subsoil permeability, and a large water capacity. The remaining soils along creeks, intermittent streams, bottomlands, and a few small upland areas are of the Sawmill, Ashkum, Peotone, and Beecher series, which are generally poorly drained. They have a black to dark gray or brown silty clay loam surface layer, high organic matter content, and a large water capacity.

1.6. Seismicity

No tectonic features within 135 km (62 mi) of Argonne are known to be seismically active. The longest inactive local feature is the Sandwich Fault. Smaller local features are the Des Plaines disturbance, a few faults in the Chicago area, and a fault of apparently Cambrian age. Although a few minor earthquakes have occurred in northern Illinois, none has been positively associated with particular tectonic features. Most of the recent local seismic activity is believed to be caused by isostatic adjustments of the earth's crust in response to glacial loading and unloading, rather than by motion along crustal plate boundaries.

Several areas of considerable seismic activity are located at moderate distances (i.e., hundreds of kilometers [thousands of feet]) from Argonne. These areas include the New Madrid Fault zone (southeast Missouri) in the St Louis area, the Wabash Valley Fault zone along the southern Illinois-Indiana border, and the Anna region of western Ohio. Although high-intensity earthquakes have occurred along the New Madrid Fault zone, their relationship to plate motions remains speculative at this time.

According to estimates, ground motions induced by near and distant seismic sources in northern Illinois are expected to be minimal. However, peak accelerations in the Argonne area may exceed 10% of gravity (the approximate threshold of major damage) once in approximately 600 years, with an error range of -250 to +450 years.

1.7. Groundwater Hydrology

Two principal aquifers are used as water supplies in the vicinity of Argonne. The upper aquifer is the Niagaran and Alexandrian dolomite, which is approximately 60 m (200 ft) thick in the Argonne area and has a piezometric surface between 15 and 30 m (50 and 100 ft) below the ground surface for much of the site. The lower aquifer is Galesville sandstone, which lies between 150 and 450 m (500 and 1,500 ft) below the surface. Maquoketa shale separates the upper dolomite aquifer from the underlying sandstone aquifer. This shale retards the movement of groundwater between the two aquifers.

Up until 1997, most groundwater supplies in the Argonne area were derived from the Niagaran, and to some extent, the Alexandrian dolomite bedrock. Delivery of Lake Michigan water to the nearby suburban areas began in 1992. Argonne now obtains all of its domestic water from the DuPage Water Commission, which obtains water from the City of Chicago water system.

1.8. Water and Land Use

Sawmill Creek flows through the eastern portion of the site. This stream originates north of the site, flows through the property in a southerly direction, and discharges into the Des Plaines River. Two small streams, one originating on-site and the other just off-site, combine to form Freund Brook, which discharges into Sawmill Creek. Along the southern margin of the property, the terrain slopes abruptly downward, forming forested bluffs. These bluffs are dissected by ravines containing intermittent streams that discharge some site drainage into the Des Plaines River. In addition to the streams, various ponds and cattail marshes are present on the site. A network of ditches and culverts transports surface runoff toward the smaller streams.

The greater portion of the Argonne site is drained by Freund Brook. Two branches of Freund Brook flow from west to east, drain the interior portion of the site, and ultimately discharge into Sawmill Creek. The larger south branch originates in a marsh adjacent to the western boundary line of the site. It traverses wooded terrain for a distance of about 2 km (1.5 mi) before discharging into the Lower Freund Pond. The Upper Freund Brook branch originates within the central part of the site and also discharges into the Lower Freund Pond.

Treated sanitary and laboratory wastewater from Argonne are combined and discharged into Sawmill Creek at location 7M in Figure 1.1. In 2012, this effluent averaged 2.28 million L/day (0.60 million gal/day), which is lower than the averages for the last few years. The combined Argonne effluent consisted of 67% laboratory wastewater and 33% sanitary wastewater. The water flow in Sawmill Creek upstream of the wastewater outfall averaged about 14 million L/day (3.6 million gal/day) during 2012, which was much lower than normal due to drought conditions throughout most of 2012.

Sawmill Creek and the Des Plaines River upstream of Joliet, about 21 km (13 mi) southwest of Argonne, receive very little recreational or industrial use. Water from the Chicago Sanitary and Ship Canal is used by Argonne for cooling tower makeup water and by others for industrial purposes, such as hydroelectric generators and condensers. Argonne usage is approximately 1.8 million L/day (0.49 million gal/day). The canal, which receives Chicago Metropolitan Sanitary District effluent water, is used for industrial transportation and some recreational boating. Near Joliet, the river and canal combine into one waterway, which continues until it joins the Kankakee River to form the Illinois River about 48 km (30 mi) southwest of Argonne. The Dresden Nuclear Power Station complex is located at the confluence of the Kankakee, Des Plaines, and Illinois Rivers. This station uses water from the Kankakee River for cooling and discharges the water into the Illinois River. The first downstream location where river water is used as a community water supply is at Peoria, which is on the Illinois River about 240 km (150 mi) downstream of Argonne. In the vicinity of Argonne, only subsurface water (from both shallow and deep aquifers) and Lake Michigan water are used for drinking purposes.

The principal recreational area near Argonne is the Waterfall Glen Forest Preserve, which surrounds the site (see Section 1.2 and Figure 1.1). The area is used for hiking, skiing, biking, and horseback riding. Sawmill Creek flows south through the eastern portion of the preserve on its way to the Des Plaines River. Several large forest preserves of the Forest Preserve District of Cook County are located southeast of Argonne and the Des Plaines River. The preserves include the McGinnis and Saganashkee Sloughs, as well as other smaller lakes. These areas are used for picnicking, boating, fishing, and hiking. A small park located in the eastern portion of the Argonne site (Location 12O in Figure 1.1) is for use by Argonne and DOE employees. A local municipality also has use of the park for athletic events. The park contains a day-care center for children of Argonne and DOE employees.

1.9. Vegetation

Argonne lies within the Prairie Peninsula of the Oak-Hickory Forest Region. The Prairie Peninsula is a mosaic of oak forest, oak openings, and tall-grass prairie occurring in glaciated portions of Illinois, northwestern Indiana, southern Wisconsin, and sections of other states. Much of the natural vegetation of this area has been modified by clearing and tillage. Forests in the Argonne region, which are predominantly oak and hickory, are somewhat limited to slopes of shallow, ill-defined ravines or low morainal ridges. Gently rolling to flat intervening areas between ridges and ravines were predominantly occupied by prairie before their use for agriculture. The prevailing successional trend in these areas, in the absence of cultivation, is toward oak-hickory forest. Forest dominated by red oak and basswood may occupy more pronounced slopes. Poorly drained areas, streamside communities, and floodplains may support forests dominated by silver maple, elm, and cottonwood. Figure 1.3 shows the vegetation communities on the Argonne site.

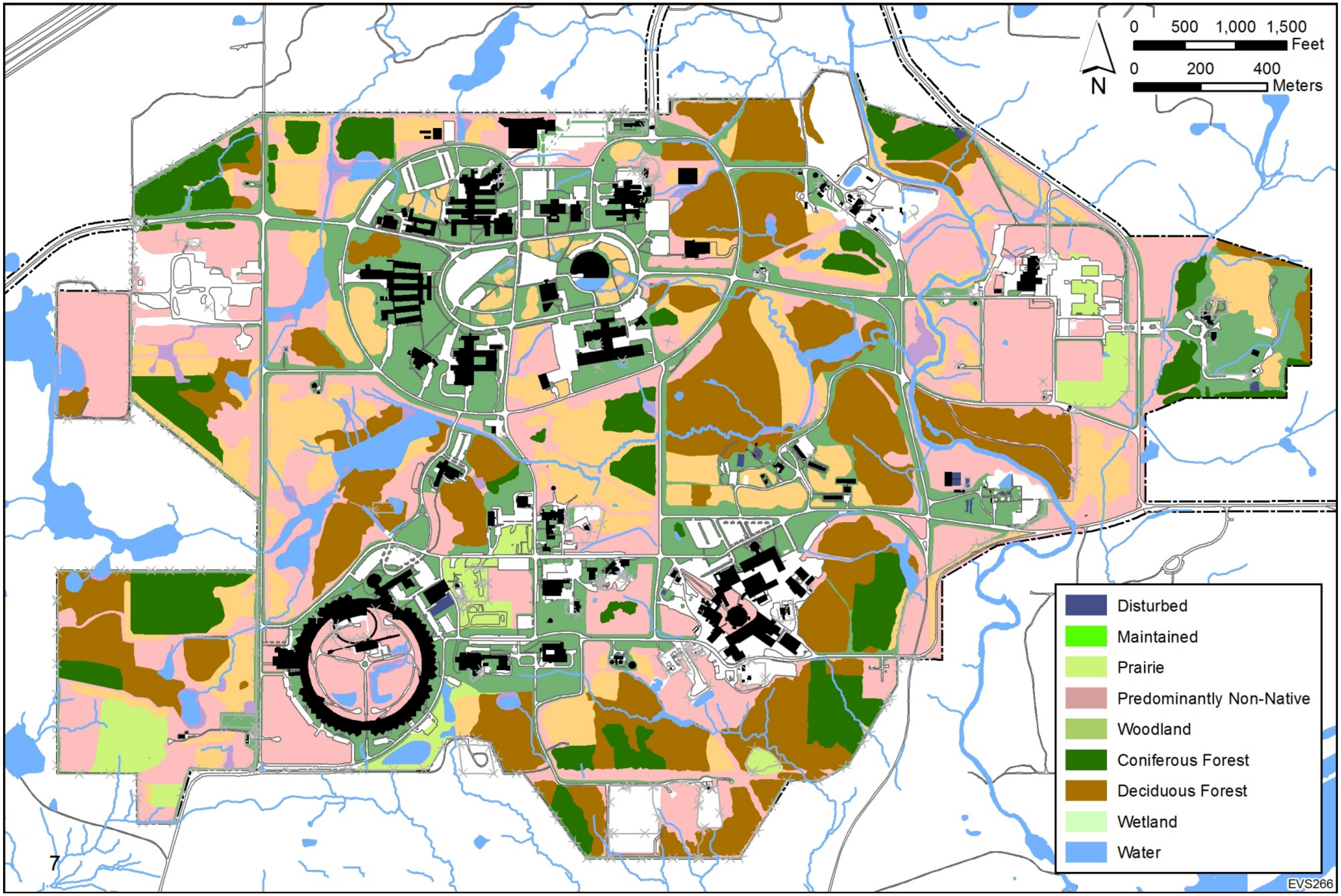


FIGURE 1.3 Argonne Vegetation Communities

Early photographs of the site indicate that most of the land that Argonne now occupies was actively farmed. About 75% was plowed field and 25% was pasture, open oak woodlots, and oak forests. Starting in 1953 and continuing for three seasons, some of the formerly cultivated fields were planted with jack, white, and red pine trees. Other fields are dominated by bluegrass.

The deciduous forests on the remainder of the site are dominated by various species of oak, generally as large, old, widely spaced trees, which often do not form a complete canopy. Their large low branches indicate that they probably matured in the open, rather than in a dense forest. Other upland tree species include hickory, hawthorn, cherry, and ash.

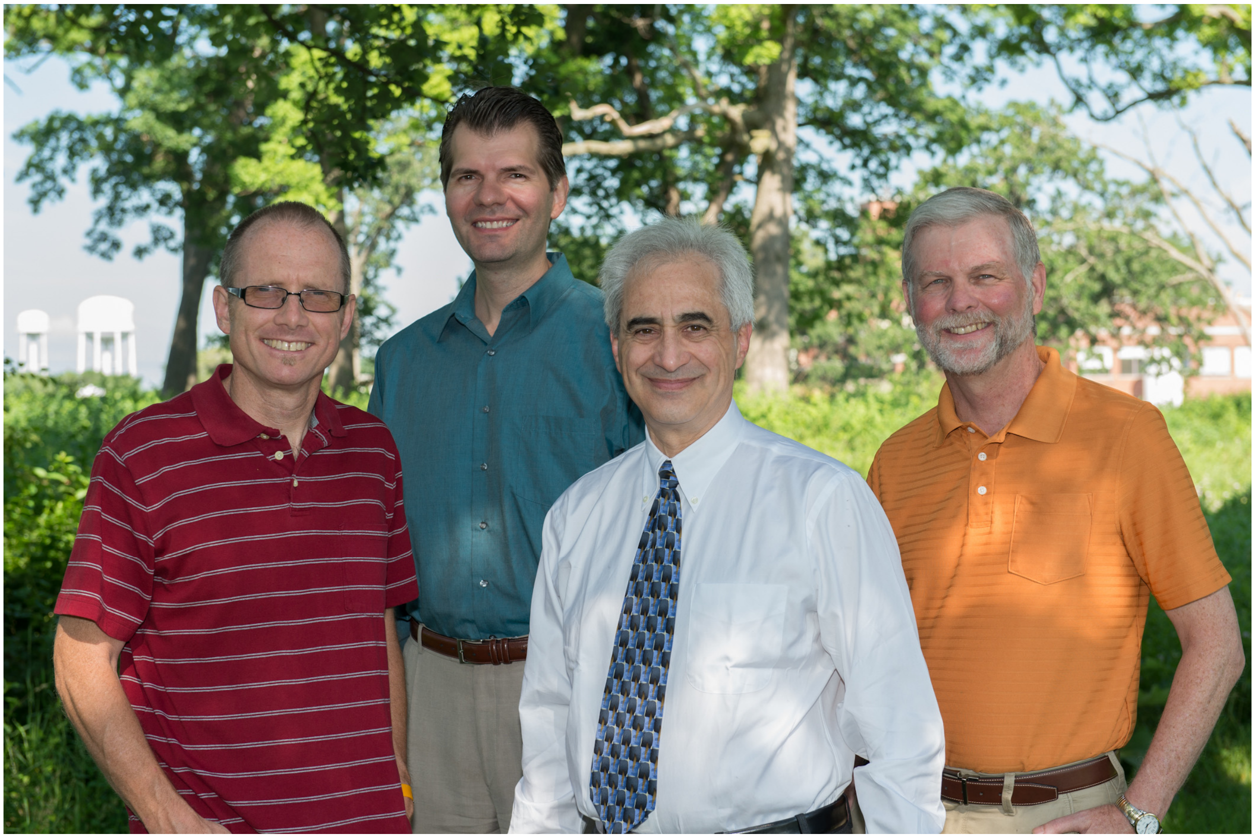
1.10. Fauna

Terrestrial vertebrates that are commonly observed or likely to occur on the site include about 5 species of amphibians, 7 species of reptiles, 40 species of summer resident birds, and 25 species of mammals. More than 100 other bird species can be found in the area during migration or winter; however, they do not nest on the site or in the surrounding region. An unusual species on the Argonne site is the fallow deer, a European species that was introduced to the area by a private landowner prior to government acquisition of the property in 1947. A population of native white-tailed deer also inhabits the Argonne site. The white-tailed and fallow deer populations are each maintained at a target density of 15 deer/mi^2 under an ongoing deer management program. Over the past few years, the fallow deer population has decreased significantly. Only a few deer are still present on the site.

Freund Brook crosses the center of the site. The gradient of the stream is relatively steep, and riffle habitat predominates. The substrate is coarse rock and gravel on a firm mud base. Primary production in the stream is limited by shading, but diatoms and some filamentous algae are common. Aquatic macrophytes include common arrowhead, pondweed, duckweed, and bulrush. Invertebrate fauna consist primarily of dipteran larvae, crayfish, caddisfly larvae, and midge larvae. Few fish are present because of low summer flows and high temperatures. Other aquatic habitats on the Argonne site include beaver ponds, artificial ponds, ditches, and Sawmill Creek.

The biotic community of Sawmill Creek is relatively impoverished, which reflects the creek’s high silt load, steep gradient, and historic release of sewage effluent from the Marion Brook sewage treatment plant north of the site. The fauna consists primarily of blackflies, midges, isopods, flatworms, segmented worms, and creek chubs. A few species of minnows, sunfish, and catfish are also present. Clean-water invertebrates, such as mayflies and stoneflies, are rare or absent. Fish species that have been recorded in Argonne aquatic habitats include black bullhead, bluegill, creek chub, golden shiner, goldfish, green sunfish, largemouth bass, stoneroller, and orangespotted sunfish.

2. COMPLIANCE SUMMARY



Argonne is a U.S. government-owned, contractor-operated research and development (R&D) facility that is subject to environmental statutes and regulations administered by the U.S. Environmental Protection Agency (EPA), the Illinois Environmental Protection Agency (IEPA), the U.S. Army Corps of Engineers (COE), and the State Fire Marshal, as well as to numerous DOE Orders and Executive Orders (EOs). The status of Argonne during 2012 with regard to these authorities is discussed in this chapter.

The Atomic Energy Act of 1954 (AEA) was enacted to assure the proper management of radioactive materials. Under the act, DOE regulates the control of radioactive materials under its authority. Sections of the act authorize DOE to set radiation protection standards for itself and its contractors. Accordingly, DOE promulgated a series of regulations (e.g., Title 10 of the *Code of Federal Regulations*, Parts 820, 830, and 835 [10 CFR Parts 820, 830, and 835], and DOE Orders 435.1, 436.1, and 458.1) to protect public health and the environment from potential risks associated with radioactive materials. This Site Environmental Report (SER) is used to document compliance with these regulations and orders.

2.1. Clean Air Act

The Clean Air Act (CAA) is a federal statute that addresses the emission of regulated air pollutants, which includes criteria pollutants (carbon monoxide, sulfur dioxide, lead, nitrogen dioxide, particulate matter, and ozone), hazardous air pollutants (HAPs), and ozone-depleting substances. Along with criteria pollutants, a Supreme Court decision in 2007 held that greenhouse gases (CO_2, CH_4, N_2O, HFCs, PFCs, SF_6) are regulated air pollutants under the Clean Air Act. In 2011 the first EPA regulations pertaining to greenhouse gases (GHG) became effective.

The program for compliance with the requirements of the CAA is implemented by the individual states through a State Implementation Plan (SIP) that describes how that particular state will ensure compliance with the air quality standards for stationary sources.

Under Title V of the Clean Air Act Amendments of 1990, Argonne submitted a Clean Air Act Permit Program (CAAPP) application to the IEPA for a site-wide, federally enforceable, operating permit to cover emissions of all regulated air pollutants at the facility. The finalized CAAPP (Title V) permit was issued on April 3, 2001. This permit supersedes the prior individual state air pollution control permits, with two exceptions for prior open-burning permits. The open-burning permits are renewed each year. Argonne meets the definition of a major source because of potential emissions of oxides of nitrogen in excess of 100 tons/yr, carbon monoxide in excess of 100 tons/yr, or sulfur dioxide in excess of 100 tons/yr at the Building 108 central heating plant.

The current CAAPP permit was renewed and became effective on October 17, 2006. The renewal application for this permit, which expired in 2011, was submitted to IEPA during a meeting in Springfield on August 2, 2010 and received a Determination of Completeness on August 3. As of the end of 2012, no action had been taken by IEPA on Argonne’s CAAPP permit renewal application; therefore, the conditions of the permit issued in 2006 remain in effect.

Facilities that are subject to Title V must characterize emissions of all regulated air pollutants, not only those that qualify as major sources. In addition to oxides of nitrogen and sulfur dioxide, Argonne also must evaluate emissions of carbon monoxide, particulates, volatile organic compounds (VOCs), HAPs (a list of 180 chemicals, including radionuclides), and ozone-depleting substances. In 2012 with a court ruling that greenhouse gases are regulated air pollutants, carbon dioxide, methane, and nitrous oxide emissions must also be evaluated and included. The air pollution control permit program requires that facilities pay annual fees on the basis of the total amount of regulated air pollutants (except carbon monoxide [CO] and greenhouse gases [GHG]) they are allowed to emit.

The Argonne site contains a large number of air emission point sources. The vast majority are laboratory ventilation systems used for bench-scale research activities. For purposes of the Title V permit, these activities are categorized as insignificant, except in cases involving the emission of radionuclides.

In January, 2012, the alkali metal reaction booth in Building 308, which had been categorized as an insignificant activity, was re-permitted as a significant activity due to an expected increase in operations. In December, 2012, a construction permit application was submitted to IEPA for the combined heat and power (CHP) project, which would install a gas-fired turbine at the Central Heating Plant to produce electricity as well as steam. To avoid Prevention of Significant Deterioration/New Source Review (PSD/NSR) requirements, Boiler No. 3 will be permanently retired and the historical emissions used to net out of PSD/NSR applicability.

2.1.1. National Emission Standards for Hazardous Air Pollutants

The National Emission Standards for Hazardous Air Pollutants (NESHAP) constitute a body of federal regulations that set forth emission limits and other requirements, such as monitoring, recordkeeping, and operational and reporting requirements, for activities generating emissions of HAPs. Significant NESHAPs affecting Argonne operations include those for radionuclides, asbestos, and emissions from reciprocating internal combustion engines and gasoline dispensing facilities. In December, 2012, the NESHAP regulation that is applicable to HAP emissions from institutional boilers at area sources was issued with a compliance date of March 21, 2014. EPA had also announced that final changes to the RICE NESHAP regulation, which affects Argonne's emergency generators, would be completed by December, 2012; however, the issuance of the changes to this rule were delayed until January, 2013. Changes to this rule should take effect on May 3, 2013.

2.1.1.1. Asbestos Emissions

Many buildings on the Argonne site contain large amounts of asbestos-containing material (ACM), such as thermal system insulation around pipes and tanks, spray-applied surfacing material for fireproofing, floor tile, and asbestos-cement (Transite) panels. This material is removed as necessary during renovations or maintenance of equipment and facilities. The removal and disposal of this material are governed by the asbestos NESHAP.

Argonne maintains an asbestos abatement program designed to ensure compliance with this and other regulatory requirements. ACM is removed from buildings either by Argonne personnel or outside contractors licensed by the Illinois Department of Public Health (IDPH). All removal work is performed in accordance with both NESHAP and Occupational Safety and Health Administration (OSHA) requirements governing worker safety at ACM removal sites. A separate portion of the asbestos removal standards contains requirements for disposing of ACM. Off-site shipments are to be accompanied by completed shipping manifests.

Approximately 133.3 m^3 (4,708 ft^3) of ACM was generated from Argonne asbestos removal projects during 2012. The 131 small removal projects that were completed generated 42.9 m^3 (1,514 ft^3) of ACM waste. Twelve large removal projects generated the remaining 90.4 m^3 (3,194 ft^3) of ACM waste. Table 2.1 provides asbestos abatement information for the large removal projects. The IEPA was notified during December 2012 that no more than 28.3 m^3 (1,000 ft^3) of ACM waste is expected to be generated from small-scale projects during 2013.

2.1.1.2. Radionuclide Emissions

The NESHAP standard for radionuclide emissions from DOE facilities (40 CFR Part 61, Subpart H) establishes the emission limits for the release of radionuclides other than radon to the air and the corresponding requirements for monitoring, reporting, and recordkeeping. A number of emission points at Argonne are subject to these requirements and are operated in compliance with them.

The amount of radioactive material released to the atmosphere from Argonne emission sources is extremely small, contributing little to the off-site dose. The maximum potential off-site dose to a member of the general public for 2012 was 0.0044 mrem, which is approximately 0.04% of the 10 mrem/yr EPA standard. Section 4.7.1 and the 2012 NESHAP report contain more detailed discussions of these emission points and compliance with the standard.

On July 11–12, 2012, a radionuclide NESHAP inspection was conducted by the U.S. EPA Region 5. Administration of this NESHAP is the responsibility of the EPA rather than the IEPA. No noncompliances were identified during the course of this inspection.

2.1.2. Conventional Air Pollutants

The Argonne site contains a number of sources of conventional air pollutants, including a steam plant, gasoline and ethanol/gasoline blend fuel-dispensing facilities, waste handling

TABLE 2.1

Asbestos Abatement Projects
DOE/IEPA Notification, 2012

Completion Date	Asbestos Abatement Contractor	Notification Quantity ft	Notification Quantity ft^2	Material	Building	Disposal Quantity (ft^3)	Landfill
1/5	Argonne Nuclear and Waste Management	0	450	Floor tile and mastic[a]	223	26	Tradebe[b] East Chicago, IN
1/20	Argonne Nuclear and Waste Management	0	1,130	Floor tile and mastic	205	54	Tradebe East Chicago, IN
2/7	Argonne Nuclear and Waste Management	0	600	Floor tile and mastic	350	44	Nevada Test Site[c] Mercury, NV
2/14	Argonne Nuclear and Waste Management	0	640	Floor tile and mastic	203	22	Tradebe East Chicago, IN
3/16	Atlantic Plant Services	360	3,000	Pipe and AHU insulation	205	750	Envirotech[d] Morris, IL
4/27	Argonne Nuclear and Waste Management	0	280	Floor tile and mastic	201	22	Tradebe East Chicago, IN
5/19	Argonne Nuclear and Waste Management	0	1,500	Floor tile and mastic	203	43	Tradebe East Chicago, IN
8/10	Atlantic Plant Services	438	3,600	Pipe insulation, Floor tile and mastic	200	337	Envirotech Morris, IL
8/17	Atlantic Plant Services	285	1,400	Air handling unit, Duct and pipe insulation	200	860	Envirotech Morris, IL
9/24	Argonne Nuclear and Waste Management	0	362	Transite panels	362	96	Envirotech Morris, IL
10/5	Argonne Nuclear and Waste Management	0	768	Floor tile and mastic	362	49	Tradebe East Chicago, IN
11/2	Argonne Nuclear and Waste Management and Atlantic Plant Services	0	125	Transite panels	314 Cooling Tower	891	Envirotech Morris, IL

[a] Courtesy notification, nonfriable material removed intact.

[b] Tradebe Treatment and Recycling, LLC.

[c] National Security Technologies, LLC (NSTec); waste remains on-site.

[d] Republic Services Envirotech.

facilities, an engine test facility, a surface treatment facility for etching research equipment, a number of diesel generators, and a wastewater treatment plant (WTP). These facilities are operated, and the associated activities are conducted, in compliance with applicable regulations and permit conditions.

The Title V permit requires continuous opacity and sulfur dioxide monitoring of the smoke stack from Boiler No. 5, the only one of the five boilers at the steam plant that is equipped to burn coal. The permit requires submission of a quarterly report listing any exceedances beyond emission limits for this boiler (30% opacity averaged over 6 min or 0.82 kg [1.8 lb] of sulfur dioxide per million Btu averaged over a 1-hour period). Boiler No. 5 did not burn any coal in 2012.

An annual compliance certification must be submitted to the IEPA and EPA each May 1 for the previous calendar year, detailing any deviation from the Title V permit and subsequent corrective actions. For calendar year 2012, no deviations from the Title V permit conditions were identified.

Landfill gas monitoring is conducted quarterly at the 800 Area Landfill via 4 gas wells placed into the waste area and 10 gas wells at the perimeter of the landfill. Figure 2.1 shows their locations. In addition to the wells, ambient air is sampled in 2 nearby buildings and at 3 open-air locations to assess the presence of methane. The gas monitoring near the landfill provides information on whether methane is migrating from the landfill. In 2012, no methane was detected above the action level of 2.5% methane in the landfill perimeter gas sampling wells.

A fuel-dispensing facility is located at Building 46, Grounds and Transportation. Except for ethanol vapors from alternate-fuel usage, this facility has volatile organic compound (VOC) emissions typical of any commercial gasoline service station.

Pursuant to *Illinois Administrative Code*, Title 35, Part 254 (35 IAC Part 254), Argonne submits an emissions report to the IEPA each May 1, for the previous year. The summary for 2012 is presented in Table 2.3.

2.1.3. Clean Fuel Fleet Program

Although reporting requirements for the Clean Fuel Fleet Program are still in effect under the CAA and 35 IAC Part 241, the IEPA indicated that it no longer wanted reports to be filed for model year (MY) 2012 (September 1, 2011−August 31, 2012) vehicles because all current MY vehicles meet the clean fuel fleet standards. Nevertheless, because the requirements are still in effect, in lieu of a report, DOE/Argonne Site Office (ASO) submitted a letter to the IEPA prior to November 1, 2012, certifying that all vehicles acquired in MY 2012 meet federal emission standards.

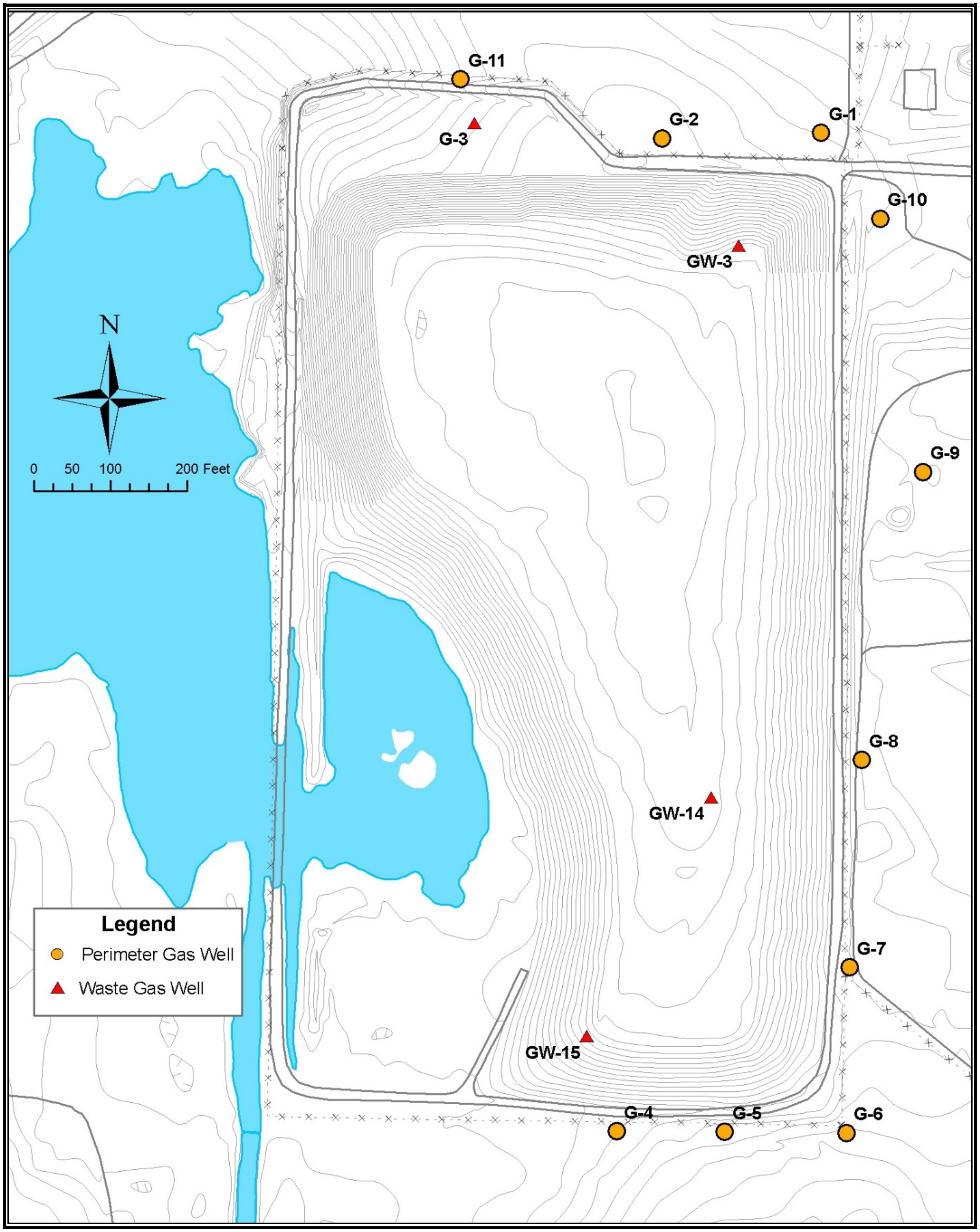


FIGURE 2.1 800 Area Landfill Gas Monitoring Wells

TABLE 2.3

Annual Emission Summary Report
(emissions in lbs/yr)

Source	CO[a]	NOx	PM/PM_{10}	$PM_{2.5}$[e]	SO_2	VOM	HAP[b]	NH_3[e]	CO_2[f]	CH_4[f]	N_2O[f]	CO_2e[f]
108 Boiler 1 (gas-fired)	23,247	27,675	2,103	526	166	1,522		136	33,254,237	627	63	33,286,852
108 Boiler 2 (gas-fired)	6,934	8,255	627	157	50	454		40	9,919,180	187	19	9,928,908
108 Boiler 3 (gas-fired)	7,117	8,473	644	161	51	466		42	10,180,724	192	19	10,190,709
108 Boiler 4 (gas-fired)	16,480	19,619	1,491	373	118	1,079		96	23,575,069	445	44	23,598,190
108 Boiler 5 (gas-fired)	9,375	13,616	848	212	67	614		55	13,410,987	253	25	13,424,140
108 Boiler 5 (coal-fired)	0	0	0	0	0	0	0	0.0	0	0	0	0
108 Temporary Boiler (gas-fired)	0	0	0	0	0	0		0.0	0	0	0	0
400 APS Generator (Caterpillar)	473	2,463	87	87	204	67		2.2	34,922	1.4	0.3	34,951
400 APS Generators - Kohler (2)	739	3,847	136	136	318	82		3.4	55,151	2.2	0.5	55,197
200 Peak Shaving Generator	0	0	0.0	0.0	0	0.0		0	0	0	0	0
202 Peak Shaving Generator	0	0	0.0	0.0	0	0.0		0	0	0	0	0
Transportation Research Fac.	3,372	12,609	917	403	784	4,702		16	245,339	9.6	1.9	246,142
PCB Tank Cleanout						0						
208 Surface Preparation Facility		9.6	<0.1	<0.1			1.8					
46 EtOH/gasoline Stg						1.2						
46 10K Gal Gasoline Stg						6.9						
308 Alkali Reaction Booth			0	0								
** These sources designated as insignificant in the Clean Air Act Permit Program (CAAPP) permit.												
370 Alkali Reaction Booth[c]			-									
363 Central Shop Dust Collector[c]			-									
212 Building Exhausts[c]			-									
368 Woodshop Dust Collector[c]			-									
108 Sulfuric Acid Stg[c]			-									
Torch Cut Pb-Based Paint[c]			-									
(R) = Radionuclide source - radionuclides except radon regulated by NESHAP (40 CFR 61 Subpart H)												
206 Alkali Reaction Booth (R)[g]												
306 Building Vents (R)			<1									
306 Chemical Photo-oxidation Unit (R)												
306 Waste Bulking Sheds (R)						0	0.0					
211 Linac (R)												
366 Wakefield Accelerator (R)												
203 ATLAS (CARIBU) (R)												
310 Demolition Project (R)												
375 Intense Pulsed Neutron Source (R)												
200 M-Wing Hot Cells (R)												
400 APS Facility (R)		71										
212 Alpha Gamma Hot Cell (R)												
350 NBL P/U Hoods (R)												
Lab Rad Hoods (R)												
WM Portable HEPA - (6) (R)			<1	<1								
303 Mixed Waste Storage (R)												
331 Rad Waste Facility (R)												
595 Lab Wastewater Plant (R)						116						
315 MACE Project (R)	44											
Total (lb/yr)	67,781	96,637	6,854	2,055	1,757	9,108	2	390	90,675,609	1,717	173	90,765,090
Total (ton/yr)	33.8905	48.3186	3.4269	1.0273	0.8786	4.5540	0.0009	0.1951	45,337.8045	0.8585	0.0866	45,382.5449
CAAPP Permit Limit (ton/yr)	(237.60)[d]	395.20	65.93	-----	332.20	21.53	10.00	-----	-----	-----	-----	

[a] Abbreviations: APS = Advanced Photon Source; CAAPP = Clean Air Act Permit Program; CO = carbon monoxide; D&D = decontamination and decommissioning; HAP = hazardous air pollutant; HEPA = high-efficiency particulate air; MACE = melt attack and coolability experiment; N_2O = nitrous oxide; NBL = New Brunswick Laboratory; NH_3 = ammonia; NO_x = oxides of nitrogen; Pb = lead; PCB = polychlorinated biphenyl; PM = particulate matter; PM_{10} = particulate matter less than 10 microns; $PM_{2.5}$ = particulate matter less than 2.5 microns; Pu = plutonium; SO_2 = sulfur dioxide; U = uranium; VOM = volatile organic matter; WMO = Waste Management Operations.

[b] Hazardous air pollutants (HAP) not included in VOM or Particulates (HCl, HF, methyl chloroform, methylene chloride).

[c] These sources designated as insignificant in the Clean Air Act Permit Program (CAAPP) permit.

[d] Not a permit limit, but is the maximum potential emission level for carbon monoxide.

[e] As of 2003 emissions of $PM_{2.5}$ and a precursor, ammonia (NH_3), must be included on the Annual Emission Report.

[f] As of 2011, greenhouse gas emissions (carbon dioxide, methane, nitrous oxide, carbon dioxide equivalents) must be included on the Annual Emission Report.

[g] (R) = Radionuclide source – radionuclides except radon regulated by NESHAP (40 CFR 61, Subpart H).

2.1.4. Greenhouse Gas (GHG) Reporting

There are two reporting requirements for the greenhouse gases carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), sulfur hexafluoride (SF_6), hydrofluorocarbons (HFCs), and perfluorocarbons (PFCs). Under Executive Order 13514, *Federal Leadership in Environmental, Energy, and Economic Performance*, in November 2011, Argonne reported to DOE Headquarters (HQ) on its Scope 1 GHG emissions (direct emissions including fugitive emissions), Scope 2 GHG emissions (indirect emissions from electrical purchases), and Scope 3 GHG emissions (indirect emissions primarily from employee activities) for FY 2012.

A second annual GHG report for calendar year (CY) 2011 was required by EPA under 40 CFR Part 98 and due by March 31, 2012. Argonne is required to report under Subpart C on GHG emissions from combustion sources. Argonne filed its greenhouse gas report for CY 2011 on the EPA Electronic Greenhouse Gas Reporting Tool (e-GGRT) system on March 21, 2012.

2.2. Clean Water Act

The Clean Water Act (CWA) was established in 1977 as a major amendment to the Federal Water Pollution Control Act of 1972 and was modified substantially by the Water Quality Act of 1987. Section 101 of the CWA provides for the restoration and maintenance of water quality in all waters throughout the country, with the ultimate goal of “fishable and swimmable” water quality. The act established the National Pollutant Discharge Elimination System (NPDES) permitting system, as the regulatory mechanism designed to achieve this goal. The authority to implement the NPDES program has been delegated to those states, including Illinois, that have developed a program substantially the same and at least as stringent as the federal NPDES program.

2.2.1. Wastewater Discharge Permitting

The NPDES permitting process administered by the IEPA is the primary tool for enforcing the requirements of the NPDES program. Before wastewater can be discharged to any receiving stream, each wastewater discharge point (outfall) must be characterized and described in a permit application. The IEPA then issues a permit that, for each outfall, contains numeric limits and monitoring frequencies on certain pollutants likely to be present, and sets forth a number of additional specific and general requirements, including sampling and analysis schedules and reporting and recordkeeping requirements. NPDES permits are effective for five years and must be renewed by the submission of a permit application at least 180 days prior to the expiration of the existing permit.

Wastewater at Argonne is generated by a number of activities and consists of sanitary wastewater (from restrooms, cafeteria sinks, and sinks in certain buildings and laboratories), laboratory wastewater (from laboratory sinks and other industrial wastewater sewers), and stormwater. Water from boiler house activities can be discharged into the DuPage County sewer system or the Argonne laboratory sewer system. Cooling water and cooling tower blowdown are generally sent to the laboratory wastewater sewer, although a very small volume is still discharged on an emergency basis only into stormwater ditches that are monitored as part of the NPDES permit. The permit authorizes the release of wastewater or stormwater from 42 separate outfalls, most of which discharge directly or indirectly into Sawmill Creek. Two of the outfalls are internal sampling points that combine to form the main wastewater outfall, Outfall 001. Table 2.4 lists these outfalls, and Figure 2.2 shows the outfall locations.

2.2.1.1. NPDES Permit Activities

Wastewater discharge at Argonne is permitted by NPDES Permit No. IL 0034592. The IEPA issued a renewed permit effective September 1, 2011. The current permit expires on August 31, 2016.

The re-issued permit reflects Argonne's continuing efforts to reduce its NPDES "footprint" with fewer outfalls requiring monthly sampling, removal of select parameters from several outfalls due to their repeated absence or very low concentrations in discharges, and removal of the TDS monitoring requirement (chloride and sulfate, two components of TDS, remain included in the permit as limited parameters). Other features of the re-issued permit include the addition of new process wastewater streams to the laboratory wastewater treatment plant originating from new programmatic buildings and chiller plants, the discharge without IEPA approval of domestic fire protection water to storm sewers during required testing activities, and the addition of dissolved oxygen as a limited parameter at the combined treatment plant outfall.

Most NPDES Permit activities historically have been associated with the observed annual cycle of TDS and chloride concentrations in wastewater discharging from Outfall 001, sometimes resulting in wintertime periodic discharge limit exceedances. These have been caused by increased boiler activity and the associated high-TDS blowdown and road salt application. To reduce impacts to the Laboratory Wastewater Treatment Plant (LWTP), boiler blowdown (up to 215,517 L/day) is periodically diverted to DuPage County during the heating season and Argonne has implemented a Snow Management Plan, focused on using alternative deicing compounds and overall reduction in deicing compound application through not plowing and deicing lightly-used roadways. The objective of the Snow Management Plan, in place since 2007, is to reduce the amount of chloride compounds from entering area waterways and wetlands by using rapidly-decomposing organic deicing alternatives, such as beet juice. Argonne believes that continued implementation of the Snow Management Plan through road and parking lot closures, pre-treatment of roadways with deicing solution before a snow event, and the increased use of organic additives will significantly reduce chloride loading to site waterways.

TABLE 2.4

Characterization of NPDES Outfalls at Argonne, 2012[a]

Outfall Number	Description	Average 2012 Flow[b]
A01	Sanitary Treatment Plant	0.201
B01	Laboratory Treatment Plant	0.401
001	Combined outfall	0.602
B03	Stormwater and groundwater discharge from the 300 Area	Stormwater only
C03	South discharge from Building 205, fire protection test discharge (FPTD) water	Stormwater only
D03	Steam trench discharge and stormwater	0.005
F03	South reach of Building 201, Building 201 fire pond overflow stormwater	Stormwater only
G03	North Building 201 storm sewer (condensate), FPTD water	0.009
H03	Stormwater, FPTD water	Stormwater only
I03	South stormwater discharge from Buildings 200 and 211, FPTD water	Stormwater only
J03	Building 213 and Building 213 parking lot stormwater, FPTD water	Stormwater only
K03	Stormwater, APS, FPTD water	Stormwater only
L03	Stormwater, APS, FPTD water	Stormwater only
M03	Stormwater, APS, FPTD water	Stormwater only
N03	Stormwater, 212 East, FPTD water	Stormwater only
004	Stormwater, emergency chiller water, FPTD water	No flow[c]
A05	Westgate Road stormwater	Stormwater only
B05	800 Area east stormwater	Stormwater only
C05	Stormwater (Building 200 West), air compressor condensate, FPTD water	0.030
D05	Stormwater	Stormwater only
E05	Building 203 west footing drainage, FPTD water	Stormwater only
006	Stormwater, emergency compressor cooling water, FPTD water	No flow[c]
007	Stormwater, FPTD water	Stormwater only
008	Transportation and grounds stormwater	Stormwater only
011	North fence line marsh storm discharge	Stormwater only
012	100 Area stormwater discharge, FPTD water	Stormwater only
013	Southeast 100 Area stormwater	Stormwater only
014	Northern East Area stormwater discharge	Stormwater only
A15, B15	Building 40 stormwater discharge	Stormwater only
A16, B16	Southern East Area stormwater discharge	Stormwater only
018	Eastern 300 Area stormwater, compressor condensate, FPTD water	Stormwater only
020	Shooting range stormwater discharge	Stormwater only
021	319 Landfill and Northeast 317 Area	Stormwater only
A22	Southern 317 Area	Stormwater only
B22	Western 317 Area	Stormwater only
023	Southern and Eastern 800 Area Landfill stormwater runoff	Stormwater only
025	Buildings 314, 315, 316, southern APS stormwater, FPTD water	Stormwater only
026	Water Treatment Plant area stormwater	Stormwater only
027	CNM building stormwater, FPTD water	Stormwater only
028	Stormwater from HTRL building area, FPTD water	Stormwater only

[a] Abbreviations: APS = Advanced Photon Source; CNM = Center for Nanoscale Materials; HTRL = Howard T. Ricketts Laboratory.

[b] Flow is measured in million gallons per day.

[c] All process wastewater discharged to these outfalls was redirected to the laboratory sewer. There was no recordable wastewater flow in 2012.

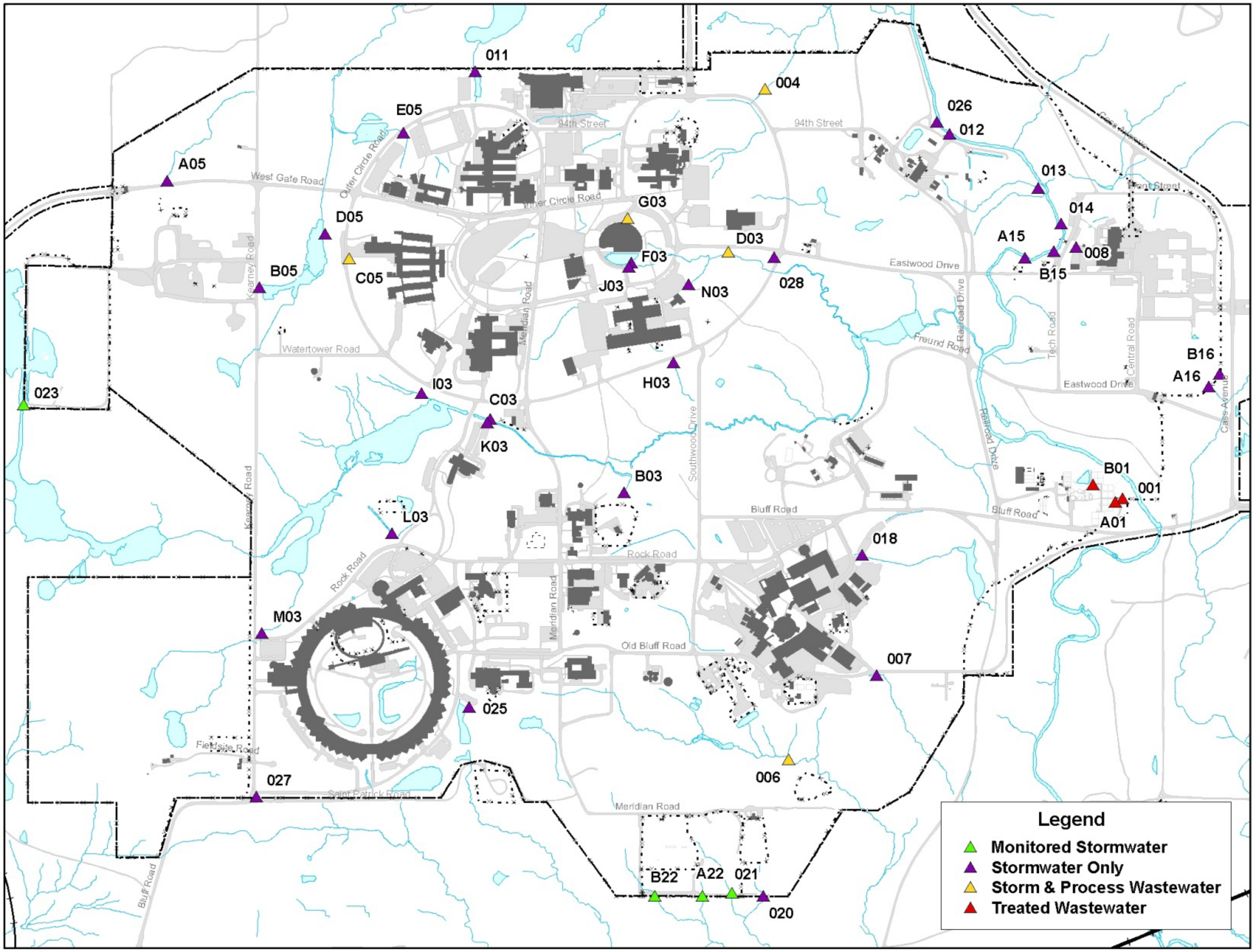


FIGURE 2.2 NPDES Outfall Locations

2.2.1.2. Compliance with NPDES Permit

Wastewater is treated at Argonne in two independent treatment systems; the sanitary system and the laboratory system. The sanitary wastewater collection and treatment system collects wastewater from sanitation facilities, the cafeteria, office buildings, some of the small industrial discharges that cannot be routed to the laboratory sewer, and other portions of the site that do not contain radioactive or hazardous materials. This wastewater is treated in the sanitary wastewater treatment system, consisting of primary clarifiers, trickling filters, secondary clarifiers, and slow sand filters. Wastewater generated during research-related activities, including those that utilize radioactive materials, generally flows to a series of retention tanks located in each building and is pumped to the laboratory wastewater sewer after radiological analysis and release certification. Treatment in the LWTP consists of aeration, solids-contactor clarification, and pH adjustment. Additional steps can be added, including powdered-activated carbon addition for organic removal, alum addition, and polymer addition or adjustment, if analysis demonstrates that any of these is required.

Figure 2.3 shows the two wastewater treatment systems that are located adjacent to each other. The volume of wastewater discharged from these facilities in 2012 averaged 0.76 million L/day (0.20 million gal/day) for the sanitary wastewater and 1.5 million L/day (0.40 million gal/day) for the laboratory process wastewater.

Results of the routine monitoring required by the NPDES permit are submitted monthly to the IEPA in a Discharge Monitoring Report (DMR). As required by the permit, any exceedance of permit limits or conditions is reported by telephone to the IEPA within 24 hours, and a written explanation of the exceedance is submitted with each DMR. During 2012, there were 10 exceedances of NPDES permit limits out of approximately 1,800 measurements. All exceedances were at Outfall 001. Ammonia exceeded its weekly and monthly averages in March, while the weekly average for dissolved oxygen, a new limited parameter at this outfall, was exceeded seven times and its daily minimum limit once. NPDES Permit exceedances reported in 2012 are summarized in Table 2.5.

Figure 2.4 presents the total number of permit limit exceedances each year over the past 12 years. The increase in the number of exceedances from 2005 through 2007, compared with previous years, reflects the more restrictive discharge limits in the 2005–2010 permit. The decrease in the number of exceedances since 2007 reflects the site-wide re-routing of TDS-contaminated wastewater into the Laboratory wastewater sewer system, reclassification of outfalls to stormwater-only, and continued implementation of the Snow Management Plan. Argonne anticipates fewer exceedances in 2013 based on improved performance at the sanitary wastewater treatment plant, resulting from more frequent slow sand filter bed maintenance, more frequent clarifier sludge removal, and aeration of sanitary wastewater to increase dissolved oxygen in the wastewater.

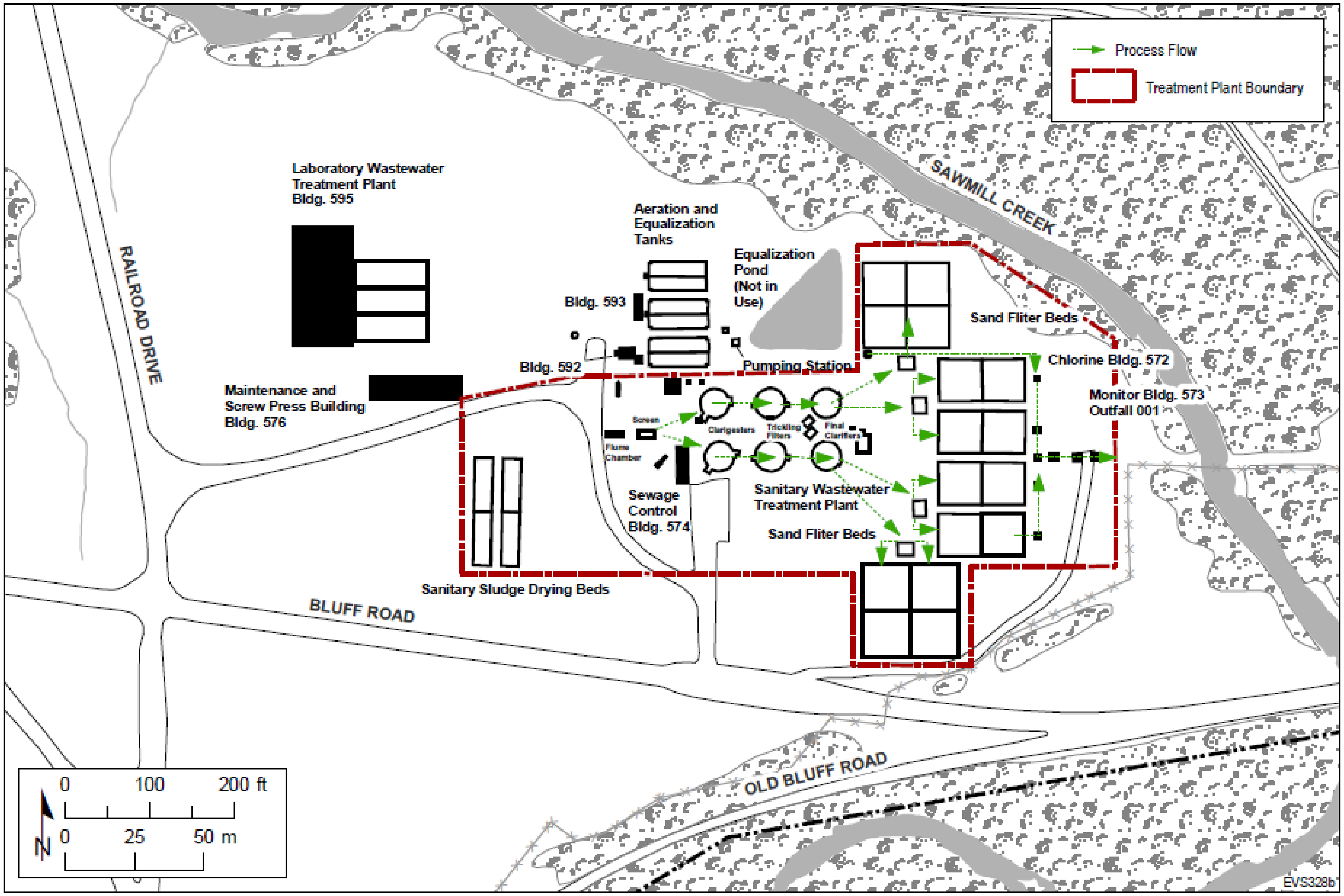


FIGURE 2.3 Argonne Wastewater Treatment Plant

TABLE 2.5

Summary of 2012 Water Effluent Exceedances

Date Reported	Outfall	Parameter	Cause
April 9 (two exceedances)	001	Ammonia (weekly average, 30-day average for March)	Inadequate maintenance of slow sand filter beds during winter months
April 10	001	Dissolved Oxygen (weekly average)	High effluent temperature caused by unseasonably warm weather
May 4	001	Dissolved Oxygen (weekly average)	High effluent temperature caused by excessively hot weather
June 22	001	Dissolved Oxygen (weekly average)	High effluent temperature caused by excessively hot weather
June 29	001	Dissolved Oxygen (weekly average)	High effluent temperature caused by excessively hot weather
July 6 (two exceedances)	001	Dissolved Oxygen (daily minimum and weekly average)	High effluent temperature caused by excessively hot weather
July 13	001	Dissolved Oxygen (weekly average)	High effluent temperature caused by excessively hot weather
July 20	001	Dissolved Oxygen (weekly average)	High effluent temperature caused by excessively hot weather

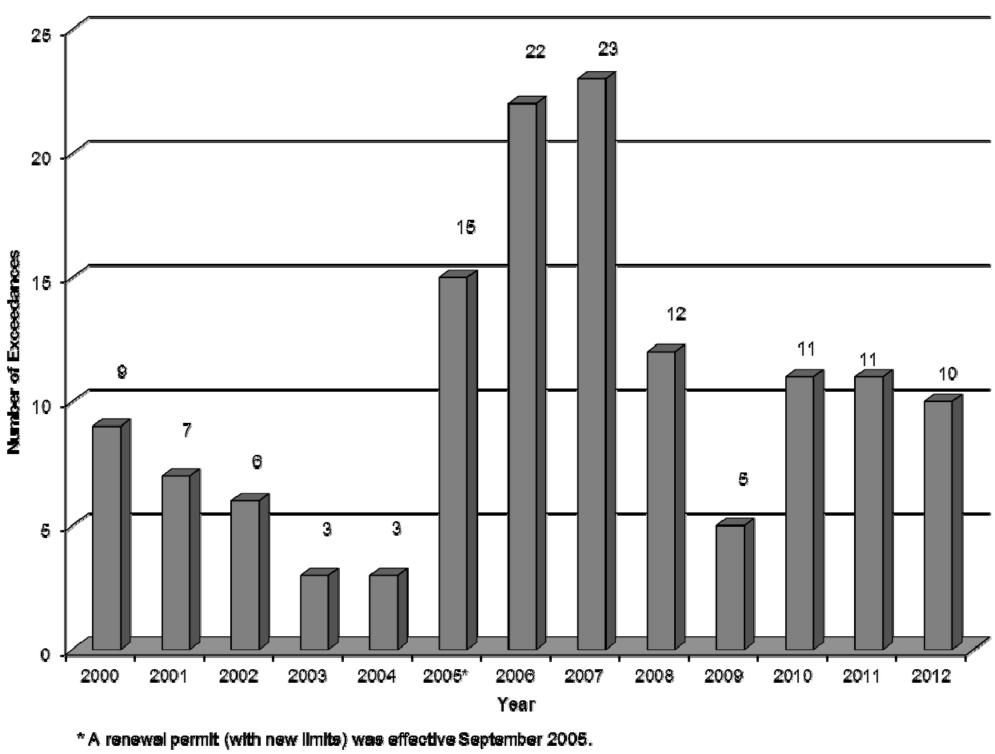


FIGURE 2.4 Total Number of NPDES Exceedances, 2000 to 2012

2.2.1.3. Priority Pollutant Analysis and Biological Toxicity Testing

The NPDES permit requires semiannual testing of Outfall B01 (the LWTP outfall) and annual testing of Outfall 021 (downstream of the 317 and 319 areas) for all the priority pollutants — 124 metals and organic compounds identified by the IEPA as being of particular concern. During 2012, the Outfall B01 samplings were conducted in June and December and Outfall 021 was conducted in December. Results are summarized in Table 2.6 below.

In addition to the priority pollutant analysis, the permit requires annual biological toxicity testing of the combined effluent stream, Outfall 001. This testing was conducted on June 19 and 20, 2012. The data indicate that the effluent was not acutely toxic to either the fathead minnow or the water flea.

2.2.1.4. Stormwater Regulations

In November 1990, the EPA promulgated regulations governing the permitting and discharging of stormwater from industrial sites. The Argonne site contains a large number of small-scale operations that are considered industrial activities under these regulations and they are subject to these requirements. An extensive stormwater characterization and permitting program was initiated in 1991 and continues as required by the present NPDES permit. Argonne's NPDES permit includes both industrial and stormwater discharges to surface water.

TABLE 2.6

Summary of 2012 Priority Pollutant Results

Outfall	Results (μg/L)	Comments
B01	<u>June:</u> Bromodichloromethane (0.5) Bromoform (0.7) Chloroform (0.6) Dibromochloromethane (0.6)	Present at estimated concentrations. Compounds detected are trihalomethane-type compounds resulting from chlorination of drinking water. The limit for THM is 80μg/L.
	<u>December:</u> Bromodichloromethane (1.0) Bromoform (1.0) Chloroform (1.0) Dibromochloromethane (1.0)	
021	<u>December:</u> Chloroform (0.8) Carbon tetrachloride (0.4) Tetrachloroethylene (0.2) 1,1-Dichloroethane (0.3) 1.1.1-Trichloroethane (0.8)	Present at estimated concentrations. Presence likely the result of surface water contact with VOC-contaminated soil associated with the 317 Area French Drain, which is currently undergoing remediation.

Special Condition 9 of Argonne's permit requires the Laboratory to maintain its Stormwater Pollution Prevention Plan (SWPPP), as well as to modify it as necessary to ensure compliance with all provisions of the stormwater regulations. Special Condition 9 also requires Argonne to inspect and report annually on the effectiveness of the site-wide SWPPP. The annual SWPPP assessment consists of tours of building exteriors residing in Argonne outfall watersheds to identify any potential pollutant sources and/or conditions that may lead to industrial discharges into the outfalls. Outfall watersheds are also inspected to verify that no changes have occurred that may affect the permitted discharges at the outfalls. Finally, SWPPP "best management practices" are evaluated to ensure that potential surface water pollution sources remain under good institutional control.

The 2012 annual inspection was completed and a report was submitted to the IEPA in October. The 2012 SWPPP assessment identified nine instances where best management practices were not being implemented. At seven buildings, drums and smaller containers containing regulated waste were stored outdoors and not within secondary containment, several drums were unlabeled, two storm drains were noted to be clogged with debris, large oil staining was noted on pavement, and large soil stockpiles did not have adequate erosion and stormwater controls. All issues identified during the 2012 assessment have been resolved.

Notable best management practices in 2012 include the Housekeeping Inspection Program and the Clean Sweep Program, as well as the continued implementation of the site-wide Snow Management Plan (discussed above). In the 2012 winter season, Argonne salt (sodium and calcium chloride) usage was low compared to the previous season due to lower volumes of snow. Additionally, beet juice continued to be used as a replacement for calcium and potassium chloride salt additives.

At Argonne, spills are reported to emergency responder personnel primarily via the on-site 911 alert system. During 2012 there were 16 spills, both indoors and outdoors, across the Argonne site, as summarized below:

- Eight spills involved oil materials, six of which were minor in nature, quickly contained and remediated without any impact to surface water. Releases of oily materials typically involved hydraulic line breaks from trucks and excavating equipment and leaking transmission fluid.

- Seven releases of water (two domestic water releases, four canal water, and one laboratory water), some of which occurred indoors and some outdoors, resulted from a mixture of failing hardware and breaches in piping. Four of these releases (three canal water line breaks and one domestic water release from a fire protection feed line) entered site storm sewers or waterways and therefore were reported to the IEPA in accordance with the NPDES permit.

- One spill involved the release of several ounces of dilute hydrofluoric acid onto the floor inside a laboratory. The spill was quickly contained and no acid was released to the environment.

2.2.2. Spill Prevention Control and Countermeasures Plan

The SPCC Plan regulations were finalized in 2002, and then amended in 2006, 2008, and 2009; the most recent requirements became effective on November 10, 2011. Argonne maintains a Spill Prevention Control and Countermeasures (SPCC) Plan as required by the Clean Water Act (CWA) and EPA regulations at 40 CFR Part 112. This plan describes the planning, design features, and response measures in place to prevent oil or oil products from being released into navigable waters of the United States. Persons with specific duties and responsibilities in such situations are identified, as are reporting and recordkeeping requirements mandated by the regulations. Annual training is conducted on implementation of this plan and SPCC requirements are regularly communicated to Argonne research and operations divisions as needed. In 2012, there were no spills that required external notification as described in the SPCC Plan.

2.2.3. General Effluent and Stream Quality Standards

In addition to specific NPDES permit-required monitoring, Argonne's discharges are monitored to determine if they conform to the general effluent limits contained in 35 IAC Part 304. During 2012, the wastewater was found to be in conformance with these standards. Samples are also collected to determine if Sawmill Creek meets IEPA General Use Water Quality Standards (WQSs) found in 35 IAC Part 302, Subpart B. None of the Sawmill Creek samples collected in 2012 exceeded the water quality standards. Chapter 5 of this report, which presents the results of the nonradiological environmental monitoring program, describes the general effluent limits and WQSs and discusses conformance with these limits.

2.3. Resource Conservation and Recovery Act

The Resource Conservation and Recovery Act of 1976 (RCRA) and its implementing regulations are intended to ensure that facilities that generate, treat, store, or dispose of hazardous waste do so in a way that protects human health and the environment. The Hazardous and Solid Waste Amendments of 1984 (HSWA) created a set of restrictions on land disposal of hazardous waste. In addition, the HSWA also requires that releases of hazardous waste or hazardous constituents from any Solid Waste Management Unit (SWMU) at a RCRA-permitted facility be remediated, regardless of when the waste was placed in the unit or whether the unit originally was intended as a waste disposal unit.

The RCRA program also includes regulations governing the management of underground storage tanks (USTs) containing hazardous materials or petroleum products. The IEPA has been authorized to administer most aspects of the RCRA program in Illinois. The IEPA issued a RCRA Part B permit to Argonne and DOE on September 30, 1997. The permit became effective on November 4, 1997. Argonne submitted an application to renew the permit in October 2007. The new permit was issued in April 2010 and is effective for 10 years.

The Argonne remediation program was designed to achieve compliance with all applicable environmental requirements related to assessing and cleaning up releases of hazardous materials from inactive waste sites. The corrective action portion of the RCRA Part B permit provides the primary regulatory vehicle. This program was completed on September 30, 2003. However, seven SWMUs could not be remediated to No Further Action (NFA) status. The long-term monitoring of these inactive waste sites has been incorporated into the Argonne Long-Term Stewardship (LTS) Program. Quarterly reports are transmitted to the IEPA for these inactive sites. The LTS Program is described in greater detail in Chapter 6.

Also, one new SWMU and one new Area of Concern (AOC) have been identified since the remediation was completed. Argonne sent a notice about SWMU No. 746 (Building 300 Floor Drains) to DOE in July 2004. The IEPA added this SWMU to the Argonne corrective action program in March 2005. The investigation of SWMU No 746 was completed in October 2009. The IEPA approved the NFA in March 2010. Argonne sent a notice about AOC-J (lead in soil near water towers) to DOE in November 2004. The IEPA added this AOC to the Argonne corrective action program in February 2005. The investigation for AOC-J was completed in May 2010. The investigation identified two areas of contaminated soil, which were removed. A final Remedial Action Completion Report was submitted to IEPA in June 2012. In October 2012, the IEPA determined that no further action was necessary.

2.3.1. Hazardous Waste Generation, Storage, Treatment, and Disposal

The nature of the research activities conducted at Argonne results in the generation of small quantities of a large number of waste chemicals. Many of these materials are classified as hazardous waste under RCRA. Argonne has 15 Hazardous Waste Management Units: 9 container storage units, 1 tank storage unit, 3 miscellaneous treatment units, and 2 tank chemical treatment units. Table 2.7 provides descriptions of these units. Figure 2.5 shows the locations of the major active hazardous waste treatment, storage, and disposal areas at Argonne.

Argonne prepares an annual Hazardous Waste Report. The report is submitted to the IEPA by March 1 of each year and describes the activities of the previous year. It is a summation of all RCRA waste activities including storage, treatment, and disposal. The report describing such activities during 2012 was submitted to the IEPA. The RCRA-permitted storage facilities, designed and operated in compliance with RCRA requirements, allow for accumulation and storage of waste pending off-site disposal. Argonne's on-site permitted treatment facilities address a small number of hazardous wastes generated by Argonne operations. Off-site treatment and disposal take place at approved hazardous waste treatment and disposal facilities. Hazardous and nonhazardous wastes that were shipped during 2012 are described in Table 2.8.

2.3.2. Hazardous Waste Treatability Studies

The IEPA requires that Argonne submit a report by March 15 of each year that estimates the number of hazardous waste treatability studies and the amount of waste expected to be used in the studies during the current year. One treatability study was conducted in 2012.

TABLE 2.7

Permitted Hazardous Waste Treatment and Storage Facilities, 2012

Description	Location	Purpose
Container Storage (9)		
Concrete Storage Pad	Building 331	Storage of solid radioactive waste and solid mixed waste (MW) in the form of steel-encased lead shielding containers and containerized solid MW.
Container Storage Area	Building 303 Mixed Waste Storage Facility	Storage of containers of ignitable, corrosive, oxidizing, reactive, solid hazardous, radiological, or MW.
	Building 331 Radioactive Waste Storage Facility	Storage of containers of flammable, toxic, corrosive, oxidizing hazardous, radiological, or MW.
Portable Storage Units	Building 306	Storage of hazardous, radiological, or MW (3 of 4 units).
		Bulking operations to consolidate and reduce the volume of lab-packed waste in containers (1 of 4 units).
Mixed Waste Storage	Building 306 – Storage Room A-142	Storage of ignitable MW.
	Building 306 – Storage Room A-150	Storage of solid and liquid MW.
	Building 306 – Storage Room C-131	Storage of ignitable, corrosive, and reactive hazardous waste.
	Building 306 – Storage Room C-157	Storage of corrosive and oxidizing MW.
	Building 306 – Storage Room D-001	Storage of solid MW containing toxic metal constituents.
Tank Storage (1)		
Waste Storage Tank[a]	Building 306	Storage of corrosive and toxic mixed waste and radiological liquid wastes (4,000 gal).
Treatment (5)		
Alkali Metal Passivation Booth	Building 206	Destruction of water reactive alkali metals possibly contaminated with radionuclides.
Alkali Metal Passivation Booth	Building 308	Destruction of water reactive alkali metals.
Chemical/Photooxidation Unit[a]	Building 306	Treatment of ignitable liquid MW containing organic contaminants.
Metal Precipitation System	Building 306	Treatment of aqueous, corrosive LLW, some of which is contaminated with heavy metals.
Mixed Waste Immobilization/ Macroencapsulation Unit	Building 306	Treatment of solid, semisolid, and organic liquid MW containing RCRA metals.

[a] Not in use.

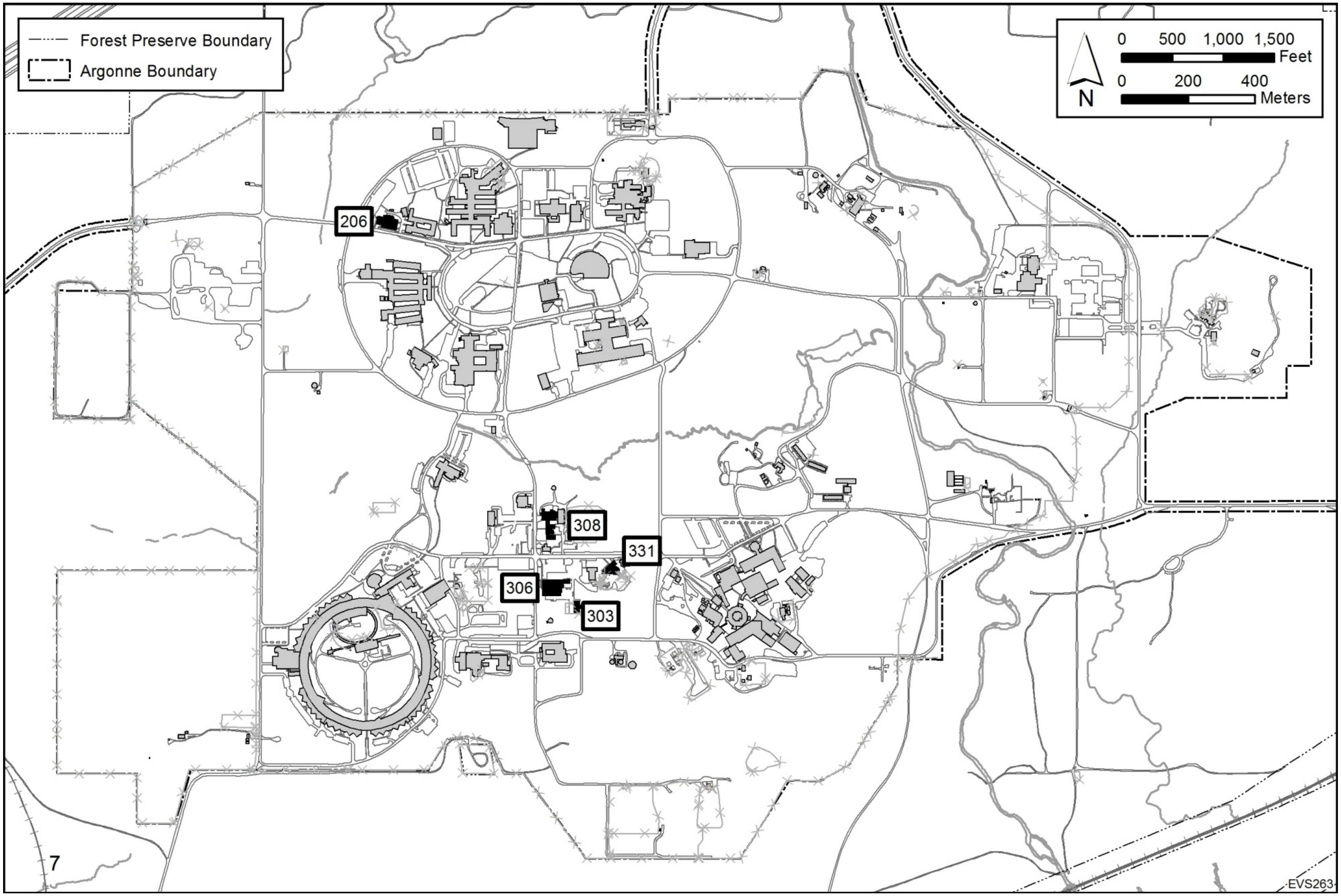


FIGURE 2.5 Major Treatment, Storage, and/or Disposal Areas at Argonne

2.3.3. Mixed Waste Generation, Storage, Treatment, and Disposal

The hazardous component of mixed waste is governed by RCRA regulations, while the radioactive component is subject to regulation under the AEA as implemented by DOE Orders. Accordingly, facilities storing or disposing of mixed waste must comply with both DOE requirements and RCRA permitting and facility standards. Argonne generates several types of mixed waste including acids, solvents, and debris contaminated with radionuclides. The RCRA Part B permit provides for on-site treatment in five mixed waste treatment systems. These systems include neutralization of low-level radioactive waste (LLRW) and stabilization of sludge and soil. During 2012, the majority of the mixed waste was sent off-site to Energy Solutions and Perma-fix out-of-state commercial treatment and disposal facilities. Mixed wastes that were generated and disposed of during 2012 are described in Table 2.9.

TABLE 2.8

Non-Rad Hazardous and Non-Hazardous Waste Shipped Off-Site, 2012

Category	Volume (ft^3)
Non-Rad Hazardous waste	2,752
Non-Hazardous waste	12,950
Recycle/Reuse waste	476
Total	16,178

TABLE 2.9

Radioactive Mixed Waste, 2012

Category	Volume (ft^3)
Generated	
Low Level Waste	8,468
Mixed Low Level Waste	1,928
TRU Waste	1,688
TOTAL	12,084
Shipped	
Low Level Waste	6,821
Mixed Low Level Waste	2,142
TRU waste	468
TOTAL	9,431

2.3.4. Federal Facility Compliance Act Activities

The Federal Facility Compliance Act of 1992 (FFCA) amended RCRA to clarify the application of its requirements and sanctions to federal facilities. The FFCA also requires that DOE prepare mixed-waste treatment plans for DOE facilities that store or generate mixed waste. The Proposed Site Treatment Plan (PSTP) for mixed waste generated at Argonne was submitted to the IEPA and the Illinois Department of Nuclear Safety in March 1995. Argonne's RCRA Part B permit provides for on-site treatment of certain mixed waste as required by the PSTP. An update to the PSTP was provided to DOE showing that mixed wastes at Argonne have been stored less than one year.

2.3.5. Underground Storage Tanks

The Argonne site currently contains 12 USTs. Seven of the existing tanks are being used to store fuel oil. The on-site maintenance facility (Building 46) uses the other five underground tanks to store diesel, gasoline, used oil, antifreeze, and an ethanol/gasoline blend. On October 20, 2011, the Illinois State Fire Marshal certified that the USTs at Argonne are in compliance with the regulations. The Illinois State Fire Marshall conducts a certification inspection every two years.

2.4. Solid Waste Disposal

Argonne generates a large volume and variety of wastes. Table 2.8 lists the non-rad hazardous and non-hazardous waste shipped during 2012. All non-recycled nonhazardous special wastes generated at Argonne in 2012 were disposed of at permitted off-site landfills.

2.5. National Environmental Policy Act

The National Environmental Policy Act of 1969 (NEPA) established a national environmental policy that promotes consideration of environmental impacts in federal or federally-sponsored projects. NEPA requires that the environmental impacts of proposed actions with potentially significant effects be considered in an Environmental Assessment (EA) or in an Environmental Impact Statement (EIS). DOE has promulgated regulations at 10 CFR Part 1021 that list classes of actions that ordinarily require those levels of documentation or that are categorically excluded from further NEPA review. No EA's or EIS's were prepared during 2012.

2.6. Safe Drinking Water Act

The Safe Drinking Water Act of 1974 (SDWA) established a program to ensure that public drinking water supplies are free of potentially harmful materials. This mandate is carried out through the institution of national drinking water quality standards, such as maximum contaminant levels and maximum contaminant level goals, as well as through the imposition of wellhead protection requirements, monitoring requirements, treatment standards, and regulation of underground injection activities. The regulations implementing the SDWA set forth requirements to protect human health (primary standards) and provide aesthetically acceptable water (secondary standards).

In January 1997, Argonne incorporated Lake Michigan water as its domestic source water, thereby replacing the dolomite groundwater that formerly constituted its source of drinking water. Because the Lake Michigan water is purchased from the DuPage Water Commission, Argonne is now a customer, rather than a supplier of water. Consequently, on January 23, 1997, the DuPage County Health Department notified DOE that the federal and state monitoring requirements previously applicable to Argonne as a "non-transient, non-community" public water supply were no longer applicable. Nevertheless, Argonne voluntarily provides to on-site personnel the Consumer Confidence Report on drinking water quality that Argonne receives as a customer of the DuPage County Water Commission. The annual report indicates that all measured contaminants meet the drinking water standards.

During 2012, Argonne continued an informational monitoring program at the only previously used dolomite domestic well that is still operational. Quarterly samples from this well were analyzed for radionuclides and VOCs. No radionuclides or VOCs above drinking water standards were detected.

2.7. Federal Insecticide, Fungicide, and Rodenticide Act

During 2012, EPA restricted-use herbicides at Argonne were applied by an IDPH-licensed contractor who provides the chemicals used and removes any unused portions. Argonne coordinates the contractor’s activities and ensures that the chemicals are EPA-approved, that they are used properly, and that any unused chemicals are removed from the site by the contractor. Also, in 2012, a small amount of herbicide was applied to various garden plots and planting beds by in-house staff. No mixed application products are stored on-site; however, manufactured concentrates such as Round Up, a glyphosate formulation, are stored on site.

In 2012, approximately 33,265 L (8,777 gal) of diluted herbicide was applied throughout the Argonne site. Fertilizer with weed control is included in the quantity of herbicide. No separate fertilizers were applied.

2.8. Comprehensive Environmental Response, Compensation, and Liability Act

The Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) addresses the cleanup of hazardous waste disposal sites and the response to hazardous substance spills. Under CERCLA, the EPA collects site data regarding sites subject to CERCLA action through generation of a Preliminary Assessment report, followed by a Site Screening Investigation. Sites then are ranked, on the basis of the data collected, according to their potential for affecting human health or causing environmental damage. The sites with the highest rankings are placed on the National Priority List (NPL) and are subject to mandatory cleanup actions. No Argonne sites are included in the NPL. All Argonne cleanup actions were performed under the RCRA corrective actions program.

2.8.1. Emergency Planning and Community Right to Know Act (Superfund Amendments and Reauthorization Act, Title III)

Title III of the 1986 Superfund Amendments and Reauthorization Act (SARA) amendments to CERCLA is the Emergency Planning and Community Right to Know Act (EPCRA), a freestanding provision. EPCRA requires providing federal, state, and local emergency planning authorities with information regarding the presence and storage of hazardous substances and their planned and unplanned environmental releases, including plans for responding to emergency situations involving hazardous materials. Under EPCRA, Argonne submitted reports pursuant to Sections 302, 304, 311, 312, and 313, which are discussed in the following paragraphs. Table 2.10 gives Argonne’s status in regard to EPCRA.

Section 302 of SARA Title III, Planning Notification, addresses notifying and updating the Local Emergency Planning Committee (LEPC) and the State Emergency Response Commission (SERC) as to the presence of extremely hazardous substances (EHSs) at Argonne,

TABLE 2.10

Status of EPCRA Reporting, 2012

EPCRA Section	Description of Reporting	Status
Section 302	Planning notification	Required
Section 304	Extremely hazardous substance release notification	Not Required
Section 311–312	Material Safety Data Sheet/Chemical Inventory	Required
Section 313	Toxic Release Inventory reporting	Required

including laboratory usage, that exceed any EHS threshold planning quantity. The Section 302 information for 2012 was transmitted to the LEPC and SERC during February 2013.

Section 304 of SARA Title III, Extremely Hazardous Substances Release Notification, requires that the LEPC and state emergency management agencies be notified of accidental or unplanned releases of Section 302 hazardous substances to the environment. Also, the National Response Center (NRC) is notified if a release exceeds the CERCLA Reportable Quantity (RQ) for that particular hazardous substance. The procedures for notification are described in the Argonne Emergency Management Plan Implementing Procedures.

Under SARA Title III, Section 311, Material Data Safety Sheet (MSDS)/Chemical Inventory, Argonne is required to provide applicable emergency response agencies with MSDSs, or a list of MSDSs, for each hazardous chemical stored on-site. The 2012 information was uploaded and certified on the Illinois Emergency Management Agency (Illinois' SERC) database, with a hard copy submitted to DOE for transmittal to the LEPC in February, 2013.

Pursuant to EPCRA Section 312, Argonne is required to report certain information regarding inventories and the locations of hazardous chemicals to state and local emergency authorities upon request. Chemicals used in research laboratories under the direct supervision of a technically qualified individual are exempt from reporting. The report on Section 312 (Tier 2) information for 2012 was provided to the SERC, LEPC, and Argonne Fire Department during February 2013. Table 2.11 lists the hazardous chemicals reported.

Section 313 of SARA Title III, Toxic Release Inventory (TRI) Reporting, requires certain facilities to prepare an annual report entitled "Toxic Chemical Release Inventory, Form R," if annual usage of listed toxic chemicals exceeds certain thresholds. Argonne filed one report under Section 313 in 2013 for activities in 2012 for lead and lead compounds. Use of lead included machining of various types of lead articles in excess of the 100-lb reporting threshold. The lead compounds were attributed to conversion of trace amounts of lead in natural gas and oil to lead oxide. Lead compounds could also result from various reportable activities in which lead is used, such as cutting and machining. Under TRI, the lead oxide is categorized as having been "manufactured," and therefore it was reported, since as a category of lead compounds, it exceeded the 100-lb reporting threshold.

TABLE 2.11

SARA, Title III, Section 312, Chemical List, 2012

CAS No.	Name	Hazard[a]
NA[b]	Lead/acid batteries	A,C,R
7664-93-9	Sulfuric acid	A,R
75-69-4	Trichlorofluoromethane	A,C
75-45-6	Chlorodifluoromethane	P,A,C
306-83-2	Dichlorotrifluoroethane	A,C
811-97-2	Tetrafluoroethane	P,A,C
8006-61-9	Gasoline	F,A,C
NA	E85 Fuel	F,A,C
68476-30-2	Diesel Fuel #2	F,A,C
10043-01-3	Aluminum sulfate	A,C
10043-52-4	Calcium chloride (pellets)	A,C
10043-52-4	Calcium chloride solution	A,C
7681-52-9	Sodium hypochlorite	A,C
7699-45-8	Zinc bromide	A,R
24307-26-4	Mepiquat chloride	A,C
245735-90-4	Mepiquat pentaborate	A,C
10043-35-3	Boric acid	A,C
7647-14-5	Rock salt (sodium chloride)	A,C
14464-46-1	Sand	A,C

[a] Hazard: A = Acute; C = Chronic; F = Fire; P = Pressure; R = Reactive.

[b] NA = No Chemical Abstracts Service (CAS) No.

2.9. Toxic Substances Control Act

The Toxic Substances Control Act (TSCA) was enacted to require chemical manufacturers and processors to develop adequate data on the health and environmental effects of their chemical substances. The EPA has promulgated regulations to implement the provisions of TSCA. These regulations provide specific authorizations and prohibitions on the manufacturing, processing, and distribution in commerce of designated chemicals. The principal impact of these regulations at the Argonne site concerns the handling of asbestos and PCBs. Suspect PCB-containing items that are subject to TSCA regulation are identified through the Argonne PCB Item Inventory Program. Argonne has developed procedures to deal with the import/export of TSCA materials by relying on internal processes that in turn draw upon U.S. Customs Service processes.

2.9.1. PCBs In Use at Argonne

PCB items in use or in storage for reuse are tracked by the Argonne PCB Item Inventory Program. All PCB items identified by the PCB Item Inventory Program have been labeled appropriately with a unique number for inventory and tracking purposes. These items are included in the Argonne Annual PCB Document Log, which describes the location, quantity, manufacturer, and unique identification number for all PCBs on-site. This report is not submitted to regulatory agencies, but is kept on file at Argonne. The Annual PCB Document Log for 2012 was completed in May 2013. The PCBs in use at Argonne are contained in capacitors and power supplies. Waste Management Operations (WMO) processes PCB-contaminated equipment and oil for disposal. The regulations governing the use and disposal of PCBs can be found in 40 CFR Part 761.

2.9.2. Disposal of PCBs

Disposal of PCBs from Argonne operations includes materials from lab-packed, bulked, and aggregated solids shipped off-site through WMO. This includes PCB-containing materials that also contain radioactive substances, the combination of which is known as TSCA mixed waste. Tables 2.7 and 2.8 include PCB wastes in the Hazardous and Mixed Low Level categories.

2.10. Endangered Species Act

The Endangered Species Act of 1973 (ESA) is federal legislation designed to protect plant and animal resources from the adverse effects of human activities. To comply with the ESA, federal agencies are required to assess the area affected by a proposed project to determine whether it contains any threatened or endangered species, or any critical habitats of such species.

At Argonne, the applicable requirements of the ESA are identified and satisfied through the NEPA project review process. All proposed projects must provide a statement describing the potential impact on threatened or endangered species and their critical habitats. This statement is included in the general Environmental Review Form. If the potential exists for an adverse impact, this impact will be assessed further and it will be evaluated through consultation with the U.S. Fish and Wildlife Service (USFWS) and, if necessary, the preparation of a more detailed NEPA document, such as an EA or an EIS. Where appropriate, this information is shared with affected state and federal stakeholders, so that potential adverse impacts are assessed fully and any steps to minimize these impacts can be identified.

No federally-listed threatened or endangered species are known to occur on the Argonne site, and no critical habitats of federally-listed species exist on the site. Two federally-listed endangered species and one federally-listed threatened species inhabit the Waterfall Glen Forest Preserve that surrounds the Argonne property.

The Hine’s emerald dragonfly (*Somatochlora hineana*), federally- and state-listed as endangered, occurs in locations with calcareous seeps and wetlands along the Des Plaines River floodplain. Leafy prairie clover (*Dalea foliosa*), which is federally- and state-listed as endangered, is associated with dolomite prairie remnants of the Des Plaines River Valley; two planted populations of this species occur in Waterfall Glen Forest Preserve. The federally-listed threatened and state-listed endangered lakeside daisy (*Tetraneuris herbacea*) occurs as a planted population in Waterfall Glen Forest Preserve. In addition, an unconfirmed capture in Waterfall Glen Forest Preserve of an Indiana bat (*Myotis sodalis*), which is federally- and state-listed as endangered, indicates that this species may occur in the area.

Additional species known to occur in DuPage County include eastern prairie fringed orchid (*Platanthera leucophaea*), Mead's milkweed (*Asclepias meadii*), and prairie bush clover (*Lespedeza leptostachya*). Each of these species is federally-listed threatened and state-listed endangered.

Although state-listed species that occur in the area are not covered by the ESA, the following state-listed species can also be found on the Argonne site or within the vicinity of Argonne:

- Endangered
  - Black-crowned night heron (*Nycticorax nycticorax*)
  - Blanding's turtle (*Emydoidea blandingii*)
  - Eastern massasauga (*Sistrurus catenatus catenatus*)*
  - Osprey (*Pandion haliaetus*)
  - Tennessee milkvetch (*Astragalus tennesseensis*)
  - Tuckerman's sedge (*Carex tuckermanii*)
  - Yellow-crowned night heron (*Nyctanassa violacea*)

- Threatened
  - Black-billed cuckoo (*Coccyzus erythropthalmus*)
  - Buffalo clover (*Trifolium reflexum*)
  - Kirtland's snake (*Clonophis kirtlandi*)
  - Marsh speedwell (*Veronica scutellata*)
  - Shadbush (*Amelanchier interior*)

*Candidate for federal listing.

Of these, the Kirtland's snake and black-crowned night heron have been observed on Argonne property. Any impacts on these species also would be assessed during the NEPA process.

2.11. National Historic Preservation Act

The National Historic Preservation Act of 1966 (NHPA), as amended, requires federal agencies to assess the impact of proposed projects on historic or culturally important sites, structures, or objects within the area of potential effect for a proposed project. It further requires federal agencies to assess all archaeological sites, historic buildings, and objects on such sites to determine whether any of them qualify for inclusion in the NRHP. The act also requires federal agencies to consult with the State Historic Preservation Office (SHPO) and the Advisory Council for Historic Preservation (ACHP), as appropriate, when determining if proposed actions would adversely affect properties that are eligible for listing on the NRHP.

The NHPA is implemented at Argonne through the NEPA review process, as well as through the Argonne digging permit process. All proposed actions must consider the potential impact on historic or culturally important properties or artifacts and document this consideration on the Environmental Review Form. Prior to disturbing the soil, an Argonne digging permit must be obtained from the FMS Division. This permit must be signed by the designated permit reviewer only after verifying the location of nearby archaeological sites and documenting the fact that no NRHP-eligible (significant) cultural resources would be affected. If the proposed site has not been surveyed for the presence of cultural resources, a cultural resources survey is conducted by qualified personnel, and any artifacts found are documented and carefully removed. At Argonne, DOE observes the SHPO requirement by consultation with the Illinois Historic Preservation Agency (IHPA) and the ACHP, as appropriate, if proposed actions would adversely affect properties eligible for listing on the NRHP. Argonne's compliance procedures for satisfying the NHPA and DOE requirements are outlined in a Cultural Resources Management Plan (CRMP), which was approved by the IHPA and ACHP in November 2006. The five-year update of the CRMP was completed in 2011.

Cultural resources include both archaeological sites and historic structures. Roughly 240 ha (592 acres) of the Argonne site have been examined through Phase I Archaeological surveys for the presence of cultural resources. It was previously determined that the roughly 63 ha (155 acres) immediately surrounding the buildings in the 200 Area are not expected to contain intact resources as a result of past earthmoving activities. There are approximately 301 ha (745 acres) that require examination for the presence of cultural resources on the Argonne site. Past surveys have identified 55 archaeological sites on Argonne-managed property. Three of the sites have been determined eligible for listing on the NRHP. Thirty-five sites have been determined ineligible for listing on the NRHP. The remaining sites have yet to be evaluated for listing.

In 2001, Argonne completed an evaluation of all structures built prior to 1989 for potential listing on the NRHP. The survey identified the Building 200 M-Wing Caves and Buildings 203, 205, 212, 315/316, and 350 as individually eligible for listing on the NRHP. The evaluation also identified historic districts — the Main Campus District (Buildings 200, 202, 203, 205, 208, 211, and the 300 Area) and the Freund Estate District (Buildings 600 and 604 and properties 603 [pool], 606 [pavilion], and 616 [tennis courts]). Separate NHPA evaluations generally conducted as part of D&D efforts have also found the Chicago Pile-5 Reactor (CP-5); the Argonne Thermal Source Reactor, Building 301; the Physics and Metallurgy Hot Laboratory; the High Voltage Electron Microscopy Facility; the Alpha-Gamma Hot Cell Facility; and Zero Power Reactors (ZPR) VI and IX eligible for listing on the NRHP.

Compliance activities associated with the NHPA have resulted in the documentation of several properties prior to their removal. Building 301, CP-5, ZPRs VI and IX, and the Argonne Thermal Source Reactor have all been documented to Illinois Historic American Engineering Record standards. The documentation reports are on file with the Illinois State Archives. Archaeological excavations of several farmsteads and prehistoric sites occurred prior to the construction of the APS during the early 1990s. In 2003, site 11-DU-201, a mid-nineteenth century farmstead, was partially excavated, which resulted in the site being determined ineligible for listing on the NRHP.

An archaeological field assessment conducted in FY2012 examined a 90 acre plot located in the southwestern corner of the Argonne property. The area is an undeveloped ecology plot which contains two green houses, a metal butler building, and a meteorological tower. The area is west of Kearney Road and due west of the APS. The intent of the survey was to clarify the number, size, and extent of the archaeological sites in this area. Previously, 7 archaeological sites were reported in this area. The survey identified 17 archaeological sites and 14 prehistoric isolated finds. The 17 sites incorporate the previously identified 7 sites. Based on the survey, only 3 sites in the survey area are considered potentially eligible for listing on the NRHP: 11-DU-190, 11-DU-202, and 11DU-205. All 3 sites are the remains of historic farmsteads.

Other compliance activities that occurred in FY 2012 under Section 106 of the NHPA include the documentation of the Intense Pulsed Neutron Source (IPNS) to the Illinois Historic American Engineering Record Standards as mitigation for the removal of the primary control room for the historically significant IPNS. The Section 106 review for the Materials Design Laboratory was withdrawn in FY 2012 due to significant design changes. The Section 106 review for this project will be reinitiated when new design plans are developed.

2.12. Floodplain Management

Federal policy on managing floodplains is contained in EO 11988, *Floodplain Management* (May 24, 1977). In addition, 10 CFR Part 1022 describes DOE's implementation of this EO. The EO requires federal facilities to avoid, to the extent possible, adverse impacts associated with the occupancy and modifications of floodplains. To construct a project in a floodplain, DOE must demonstrate that there is no reasonable alternative to the floodplain location.

The Argonne site is located approximately 46 m (150 ft) above the nearest large body of water (Des Plaines River); thus, it is not subject to major flooding. The 100- and 500-year floodplains are limited to low-lying areas of the site near Sawmill Creek, Freund Brook, Wards Creek, and other small streams and associated wetlands and low-lying areas. These areas are delineated in Argonne's site development plan and are generally contained within areas designated for conservation use, not intended for development. No significant structures are located in these areas, although an existing pumping station and inlet structure for securing canal water as a cooling tower feedstock is situated in the floodplain of the Des Plaines River south of the site. To ensure that floodplain areas are not adversely affected, new facility construction is not permitted within these areas, unless there is no practical alternative. Any impacts on floodplains would be fully assessed in a floodplain assessment and, as appropriate, documented in the NEPA documents prepared for a proposed project.

In 2012, there were no projects or events that affected the regulatory status of floodplains on the Argonne site.

2.13. Protection of Wetlands

Federal policy on wetland protection is contained in EO 11990, *Protection of Wetlands* (May 24, 1977). In addition, 10 CFR Part 1022 describes DOE's implementation of this EO. The EO requires federal agencies to identify potential impacts on wetlands resulting from proposed activities and to minimize these impacts. Where impacts cannot be avoided, mitigating action must be taken by repairing the damage or replacing the wetlands with an equal or greater amount of a restored wetland or a man-made wetland as much like the original wetland as possible.

Section 404 of the CWA establishes a program to regulate the discharge of dredged and fill material into waters of the United States, including wetlands. The U.S. Army Corps of Engineers (COE) administers this program. Activities regulated under this program include disturbance of wetlands for development projects, infrastructure improvements, and conversion of wetlands to uplands for farming and forestry. The COE uses a permit system to identify and enforce wetland mitigation efforts.

Argonne completed a site-wide wetland delineation in 1993. All wetlands present on site were identified and mapped following the 1987 *Corps of Engineers Wetlands Delineation Manual*.[3] The delineation map shows the areal extent of all wetlands present at Argonne down to 500 m^2 (1/8th acre). Thirty-five individual wetland areas were identified; their total area is approximately 20 ha (50 acres). The larger wetlands are illustrated in Figure 1.3.

Argonne's wetland management strategy, as described in a September 2001 DOE EA, includes creating advanced compensatory mitigation. The advanced compensatory mitigation is similar to a wetland "bank" and is to be used to offset wetland losses at Argonne.

2.14. Land Management and Habitat Restoration

Land management and habitat restoration has been an area of interest. The retention of scarce habitat types and their preservation from encroachment by development, as well as protection from invasive species, is now increasingly prevalent in the Chicago region.

The land use plan for undeveloped areas is based on the tailored need for mitigation, environmental restoration, and diversification of landscape forms and materials, through the increased presence of cost-saving native species and reduction or elimination of non-native or potentially invasive plant species. Numerous initiatives have been established to return selected localities within Argonne's boundaries to more viable and self-sustaining habitat types, such as prairie and savannah, that formerly existed in this region, as well as to combat invasive species in remaining areas of high-quality habitat. Additional efforts seek to increase floristic diversity and use of native plant materials within the developed areas of the site, while reducing traditional costs for landscaping maintenance.

Argonne annually initiates 1–2 ha (3–5 acres) of prairie restoration and 12–24 ha (30–60 acres) of invasive species control. Several species of invasive plants are monitored and controlled every year. This continued through 2012, with 1 ha (3 acres) of land added to prairie conversion, and 12 ha (30) acres of woodland managed to control invasive shrubs and other plant species.

2.15. Wildlife Management and Related Monitoring

DOE manages the numbers of white-tailed and fallow deer at the site through an interagency agreement with the U.S. Department of Agriculture. DOE began the deer management program in 1995 to alleviate traffic safety hazards and ecological damage caused by extremely high deer densities. More than 600 white-tailed deer were removed in the winter of 1995 to 1996, and more than 80 deer were removed the following winter to achieve target densities of 20 deer/mi^2 for each species. Smaller numbers of deer have been removed each year since 1997.

DOE lowered its target density for white-tailed deer to 15 deer/mi^2 in 2001 to better achieve its objectives of reducing deer and vehicle collisions, allowing oak trees to regenerate, and allowing deer-sensitive herbaceous species to recover.

DOE and the Forest Preserve District of DuPage County coordinate deer management efforts in order to preserve and enhance biodiversity at Argonne and the surrounding Waterfall Glen Forest Preserve. Over the past few years, the fallow deer population has decreased significantly.

2.16. Environmental Permits

Table 2.12 lists all the environmental permits in effect at the end of 2012. Other portions of this chapter discuss special requirements of these permits and compliance with those requirements.

2.17. EPA/IEPA/DOE Inspections/Appraisals

Various inspections and appraisals were conducted during 2012. A short description of each is included in Table 2.13. Any identified issues are documented in an Argonne issues management system and tracked to completion.

TABLE 2.12

Environmental Permits in Effect, 2012

Permit Name	Permit ID	Permit Type	Start Date	End Date
200 Area Central Chiller	ILR10N399	General NPDES	8/16/2010	7/31/2013
2012 – 13 Nuisance Wildlife Control Permit	Argonne\Group Class C Permit	Nuisance Wildlife	1/31/2012	1/31/2013
B-203 CARIBU Project Construction Permit	05120055	Construction (Air Emission Source)	3/20/2006	–[a]
Building 362 Biomass Gasification	11010021	Construction	3/7/2011	12/31/2012
Building 108 Boiler #5 NO_X RACT Control	11030020	Construction	4/5/2011	–
Building 211 Linac	11030026	Construction	3/30/2011	–
Building 108 Temporary Boiler	11060051	Construction	7/22/2011	–
Building 308 Alkali Metal Reaction Booth	88120046[b]	Construction	1/6/2012	–
Building 366 Wakefield Accelerator	11080020	Construction	8/17/2011	–
Building 310 Demolition	ILR100905	General NPDES	8/23/2011	7/31/2013
Building 330 Demolition	ILR10M587	General NPDES	2/25/2010	7/31/2013
Energy Sciences Building	ILR100906	General NPDES	8/23/2011	7/31/2013
Energy Sciences Building	2011-HB-1277	Construct, own, operate (sewer connection)	4/22/2011	–
Advanced Protein Crystallization Facility	2011-HB-1916	Construct, own, operate (sewer connection)	9/30/2011	–
Advanced Protein Crystallization Facility	ILR10Q489	General NPDES	8/27/2012	7/31/2013
Building 203 Parking Lot	ILR10Q483	General NPDES	8/23/2012	7/31/2013
Site Work	ILR10O807	General NPDES	7/26/2011	7/31/2013
CAAPP Title V Permit	95090195	Operating	10/17/2006	10/17/2011[c]
Howard T. Ricketts Laboratory Construction Project	2006-EN-6007	Construction	1/12/2006	–
NPDES Wastewater Discharge Permit	IL0034592	Operating	9/1/2011	8/31/2016
General NPDES Permit for Pesticide Application Point Source Discharges	ILG870741	General NPDES	10/31/2011	10/30/2016
Open Burn Permit – Fire Training	B1206069	Operating	9/6/2012	9/6/2013
Open Burn Permit – Vegetative Control	B1203163	Operating	5/3/2012	5/3/2013
RCRA Part B Permit	IL3890008946	Operating	9/30/1997	5/6/2020
Theory and Computing Sciences (TCS) Building	2009-EN-4482	Construction	10/8/2009	–
USDA Soil Permit	P330-09-00006	Operating	1/8/2009	1/8/2012
Wastewater Discharge Permit to DuPage County	18965	Wastewater	7/29/1991	–
Wastewater Treatment Plant Land Application Permit	2009-SC-2914	Operating	12/4/2009	11/30/2014

[a] A dash indicates that the permit continues to be in effect with no expiration date.

[b] Revision of the original construction/operating permit. Converted from insignificant to significant emission unit in CAAPP permit.

[c] Permit renewal application is on file with IEPA. Current permit is in effect until permit renewal is received.

TABLE 2.13

EPA/IEPA/DOE Environmental Compliance
Inspections/Appraisals, 2012

Agency	Type	Date
PMA	Environmental Surveillance Program	Various
IEPA	Annual Resource Conservation and Recovery Act Inspection	8/6/2012
EPA	Radionuclide NESHAP Inspection	7/11-12/2012
IEPA	NPDES Annual Inspection	10/18-19/2012
IEPA	Building 203 Parking Lot	10/19/2012

3. ENVIRONMENTAL MANAGEMENT SYSTEM

The Environmental Management System (EMS) is a tool that the management team at Argonne utilizes to effectively manage and monitor the impacts its operations and processes may have on the environment and to continually improve its environmental stewardship performance. The UChicago Argonne, LLC, Board of Governors, the Laboratory Directorate, and the Laboratory Management Council are committed to ensuring that environment, safety, and health (ESH) considerations are integrated into the performance of all work.

3.1. EMS Certification

DOE Order 436.1, which implemented EO 13514 and superseded DOE Order 450.1A, requires sites to have an established and implemented EMS. According to the DOE Order, sites must maintain their EMS as being certified to or conforming to the International Organization of Standardization's (ISO) 14001:2004 in accordance with the accredited registrar provisions of the International Standard or the self-declaration instructions referenced within the ISO standard.

The ISO registrar recommended Argonne for ISO 14001:2004 certification, which was most recently issued on May 29, 2012 (see Figure 3.1). On June 8, 2012, the DOE-ASO declared that Argonne had fully implemented its EMS, consistent with the requirements of DOE Order 450.1A (the current order at the time). In parallel with the ISO 14001:2004 certification, Argonne also obtained ISO 9001:2008 certification. A full registration audit was conducted in April 2012 and a surveillance audit was conducted in November 2012. Argonne's ISO14001:2004 certification has been maintained.


NSF International Strategic Registrations

Certificate of Registration

This certifies that the Environmental Management System of

Argonne National Laboratory

9700 S. Cass Ave
Argonne, Illinois, 60439-4832, United States
has been assessed by NSF-ISR and found to be in conformance to the following standard(s):

ISO 14001:2004

Scope of Registration:
The provision of basic and applied scientific research, engineering, and technical services for the U.S. Department of Energy and other customers.

Certificate Number: 6Q721-EM5
Certificate Issue Date: 29-MAY-2012
Registration Date: 17-MAY-2012
Expiration Date *: 16-MAY-2015

William Niedzwiecki,
President & General Manager,
NSF-ISR, Ltd.

FIGURE 3.1 Argonne ISO 14001:2004 Certificate

3.2. Integration of the EMS with the Integrated Safety Management System

The Integrated Safety Management System (ISMS) is the DOE umbrella of environment, safety, and health programs and systems that provide the necessary structure for any work activity that could potentially affect a worker, the public, or the environment. The EMS is integrated into the ISMS through the Argonne Work Planning and Control (WP&C) process. As part of the work planning process, the NEPA Environmental Review Form is completed to indicate any potential environmental issues associated with the work so that the appropriate environmental subject matter expert (SME) can be engaged to assess any environmental impacts.

3.3. EMS Elements

The ISO 14001:2004 standard contains requirements which define and document the EMS program. The EMS is designed around the plan-do-check-act cycle, an interactive four-step management method used for the control and continuous improvement of processes. The most critical planning stage elements are discussed below.

3.3.1. Environmental Policy

The Argonne environmental policy is captured in LMS-POL-2 and is available to all Argonne employees and to the public via the Argonne public website. The policy states that "Argonne activities (including experiments, facility operations, construction activities, and other activities) must be conducted in an environmentally safe and sound manner consistent with Argonne permit conditions. Argonne is committed to:

- Continuous environmental improvement,
- Implementation of the environmental objectives and targets process,
- Pollution prevention and waste minimization, and
- Compliance with all applicable requirements."

This environmental policy applies to all Argonne activities that could or do have a potential impact on the environment or compliance with applicable environmental regulations.

To support this commitment, Argonne:

- Ensures that technologies, facilities, processes, and operating procedures meet or exceed applicable environmental permit expectations and regulatory requirements;

- Actively explores, creates, and communicates new ways to minimize and prevent pollution arising from all levels of research, development, and operational activities and to preserve natural resources;

- Builds partnerships inside and outside of Argonne to sustain and enhance the environment; and

- Corrects conditions promptly and responsibly to eliminate or minimize potential adverse impacts on sustainable environments.

3.3.2. Environmental Aspects and Impacts

Argonne evaluates its operations to identify those aspects of its operations that can impact the environment and to determine which of those impacts are significant. When operations have the potential for significant environmental impacts, Argonne implements the EMS to minimize or eliminate potential adverse impacts. Most of the aspects are discussed in Chapter 2. The list of environmental aspects is reviewed and updated annually.

Regulatory and organizational roles and responsibilities are delineated in the EMS Description Document to address the management of the aspects and impacts. To determine which environmental aspects are significant, a scoring methodology was applied that rates each against the four criteria of regulatory compliance, environmental consequence, mission consequence, and the likelihood of occurrence. Four aspects have been identified as being significant; regulated air emissions, wastewater discharges, waste generation, and pollution prevention/waste minimization. All facilities that have significant aspects are required to have controls in place to minimize or eliminate their negative impacts.

3.3.3. Legal and Other Requirements

Argonne monitors the environmental regulations to ensure that Argonne staff are aware of proposed changes in regulations and new regulations. A number of sources of information are reviewed to identify new or changing regulations, including:

- Monitoring *Federal Register* and *Illinois Register* notices, EPA, IEPA, and DOE websites, and newsletters;

- Attending workshops and seminars; and

- Participating in professional organizations and conferences.

New requirements are communicated to the appropriate managers and supervisors by SMEs. Evaluations are conducted to determine the impacts of proposed and final regulations on Argonne activities.

In addition to new or revised DOE Orders and regulations that prescribe requirements, Argonne uses other sources to identify opportunities for environmental improvements. These include lessons-learned reports, interaction with other DOE sites, participation in forums, Occurrence Reporting Processing System (ORPS) reports, assessments by stakeholders, and feedback from public interest groups and others.

Of particular interest is Executive Order 13514, *Federal Leadership in Environmental, Energy, and Economic Performance*, which expands on the energy reduction and environmental requirements of Executive Order 13423, *Strengthening Federal Environmental, Energy, and Transportation Management* and requires federal agencies to establish an integrated strategy towards sustainability and to make reduction of greenhouse gas emissions (GHG) a priority.

3.3.4. Environmental Objectives and Targets

Another mechanism to improve environmental performance is the annual establishment of EMS objectives and targets. Objectives describe Argonne's goals for environmental performance. The objectives are a set of measurable or qualitative goals concerning how Argonne will address each significant environmental aspect. Targets are specific measurable interim steps to be taken to obtain objectives. Targets are documentable actions with due dates. All organizations are encouraged to establish and implement environmental targets where applicable to individual programs.

For FY2012, 37 objectives/targets were established. All were completed as scheduled. Sustainability practices are a large component of Argonne's environmental objectives and targets. Sustainability practices are discussed in the following sections.

3.4. Sustainability Practices

Argonne continues to develop strategies and take actions to meet or exceed all of the goals of Executive Order (EO) 13514, *Federal Leadership in Environmental, Energy, and Economic Performance* through which President Obama called on federal agencies to set a shining example of sustainability for the rest of the nation by improving environmental, energy, and economic performance, and to achieve targeted reductions in our greenhouse gas (GHG) emissions by 2020. These strategies are outlined in the latest Argonne National Laboratory Site Sustainability Plan[31] issued in December 2012, and it captures the DOE goals for sustainability. Argonne is in its third performance year working under a Site Sustainability Plan (SSP), continuing the strong performance of previous years. The overarching goal of the SSP is one of sustainability leadership and innovation and not just compliance with the related DOE and Executive Orders. The integration of the sustainability strategy (i.e., energy and water conservation, pollution prevention, greenhouse gas [GHG] reductions, etc.) into Argonne work processes and research and development goals is foundational to the SSP. Argonne continues to make measured, systematic progress toward meeting goals for conserving electricity, reducing GHG emissions, and utilizing green practices in modernizing facility infrastructure.

Argonne's SSP is divided into 11 sections with the overall focus on 5 key areas:

- Greenhouse Gas Reduction and Energy Conservation
- High Performance Buildings
- Fleet Management
- Water Efficiency
- Pollution Prevention (P2) and Waste Reduction

Argonne has created a core team of support and research staff to manage sustainability activities. The laboratory developed overall goals within each focus area that support EO 13514 goals and Argonne's commitment to a sustainable campus. Major strategies and actions were then developed that when executed, provide the means for goal achievement. The efforts in FY2012 have not gone unnoticed.

3.4.1. Greenhouse Gas Reduction and Energy Conservation

Argonne's current carbon footprint is 311,894 metric tons (with a FY2008 baseline of 339,030 metric tons). Currently, purchased power (both direct emissions and transmission losses) represents 66% of this footprint. Natural gas combustion for steam production is currently approximately 15%. Fugitive emissions (primarily sulfur hexafluoride - SF_6) comprise the next largest component at 12%. Transportation related emissions, most of which are attributable to employee commuting and business air travel, contributes 6% with the remaining 1% attributed to on-site and off-site fugitive emissions from landfills and wastewater treatment.

Through FY2012, Argonne achieved a 22.9% energy intensity reduction for goal-subject buildings, a 33.9% potable water intensity reduction, an 8.7% reduction in Scope 1 and 2 GHG emissions, and a 1.4% reduction in Scope 3 GHG emissions.

Argonne is in the preliminary assessment phase of building a combined heat and power plant. This new combined heat and power plant will provide efficiencies in the generation and distribution of steam used to provide heat for the site. Electricity will be generated as a by-product of the proposed plant. Thus, the amount of purchased electricity could drop significantly. Also, in an effort to reduce electricity intensity and resultant GHG emissions, projects are underway involving data center consolidation, energy reduction software for desktop computers, installation of advance metering, and cool roofs. Steam usage reduction strategies involve the evaluation of heat recovery systems for facilities that use large amounts of power (for instance, the Advanced Photon Source and the high performance computing centers).

Finally, the highest risk of interfering with achieving sustainability goals lies in Argonne's growth potential. Power demands are expected to double in the next six years if Argonne continues with plans to build out exascale computing facilities. Although these facilities are exempt from energy intensity requirements, meeting GHG reduction goals will require innovative clean or renewable energy solutions.

3.4.2. High Performance Buildings

Argonne's goal is to certify 15% of its new and existing buildings (over 464 sq. m [over 5,000 sq. ft.]) as meeting or exceeding HPSB guiding principles or LEED criteria by 2015. LEED is a green building certification system developed by the U.S. Green Building Council that provides a green building design framework and certification via an independent, third-party verification that a building was built or retrofitted using high-performance or green features. The HPSB guiding principles comprise sustainability objectives and criteria developed by the federal Interagency Sustainability Working Group. Achievement of these objectives is determined through self-validation. Existing buildings that meet the LEED criteria are considered as also meeting the HPSB principles.

Six buildings currently meet these criteria, two buildings are under construction, and two buildings are currently being upgraded to meet the HPSB requirements in 2013. Six more HPSB-validated or LEED-certified buildings will be needed by FY2015, based on an expected growth of the Argonne campus to 76 buildings of 464 sq. m (5,000 sq. ft.) or more by FY2015. Argonne expects to achieve this goal by its due date.

3.4.3. Fleet Management

EO 13514 requires the laboratory to reduce fleet petroleum usage by 2% annually for carbon fuels and increase the alternative fuel usage by 10% annually from a 2005 baseline. Argonne has met and exceeded all goals related to fleet transportation. Since FY2009, Argonne has completely replaced its fleet with one that is entirely U.S. General Services Administration (GSA)-leased. The fleet manager has also introduced smaller and more fuel-efficient vehicles, including:

- 16 new compact and subcompact sedans
- 11 hybrid electric vehicles
- 26 "Neighborhood" vehicles, including 13 electric vehicles and 13 diesel-fueled tractors.

By introducing these vehicles, Argonne has been able to further reduce the number of traditional fleet vehicles to an all-time low of 119 vehicles. Additional dedicated charging stations were installed to enhance the convenience of charging the electric vehicles. Most of these stations have electricity-use tracking capabilities through the site-wide METASYS™ system.

These actions have contributed to a 38% petroleum fuel-use reduction exceeding the overall petroleum-use reduction goal of 30% by FY2020 (eight years ahead of schedule) and a 100% alternative-fuel increase compared to total fuel consumption based on an overall alternative-fuel increase goal of 100% by FY2015 (three years ahead of schedule), greatly exceeding the goals of the EO.

3.4.4. Water Efficiency

Water used at Argonne originates from two sources:

1. Potable water for domestic and laboratory use is supplied by the DuPage Water Commission and

2. Industrial water for building and process cooling is drawn from the nearby Chicago Sanitary and Ship canal.

The EO 13514 sustainability goal for potable water is to reduce the potable water intensity (gal/GSF) ratio by 26% by FY2020. By the end of FY2012, Argonne had reduced potable water consumption by 33.9%, easily exceeding the 26% FY2020 total reduction goal. A number of water conservation measures were completed or initiated in FY2012. The resulting potable water savings of 11.7 million gal/yr equated to a cost savings of $31,576 during FY2012.

The EO 13514 sustainability goal for industrial water is to reduce industrial, landscaping, and agricultural (ILA) water consumption by 20% by FY2020, relative to FY2010. Most ILA water at Argonne is used as cooling tower makeup water. During FY2012, Argonne's reduction in industrial water usage accelerated compared to previous years, being reduced by about 12.5 million gallons, a 9.3% reduction and a $14,385 cost saving. At this pace, Argonne will exceed the 20% total reduction required by FY2020. In addition to cooling tower make-up water reduction efforts, Argonne's landscaping practices continue to employ water-use reduction practices, including matching planting schedules to seasonal precipitation patterns so new plants have time to become established without intensive watering and selecting drought-tolerant plants.

3.4.5. Pollution Prevention

Argonne has implemented a site-wide Pollution Prevention/Waste Minimization (P2/WM) program in accordance with its RCRA Part B Permit, and DOE Order 436.1. The P2 program tracks the generation of waste and recyclable material at Argonne and monitors the progress with regard to goals established in Argonne's Site Sustainability Plan.

Argonne management fosters a work environment that promotes the development and implementation of P2 activities. Argonne has established a P2 policy statement and a requirement that all new project reviews include the use of a P2 review checklist. In addition, Argonne uses the ISMS to promote and institutionalize P2 strategies across the Argonne site.

3.4.5.1. Pollution Prevention Opportunity Assessment Activities

Historically, those involved in the Argonne P2 program have identified, developed, and performed Pollution Prevention Opportunity Assessments (PPOAs). PPOAs are reviews of programs, projects, and activities to determine what changes can be made to reduce or eliminate waste or pollution. During 2012, five PPOAs were conducted. A description of each PPOA follows.

- Evaluate the feasibility of replacing bottled water delivery service with sustainable alternatives. As a result, Argonne began the process to replace the bottled water delivery service with filtered water units, which saves money, cuts down on GHG emissions resulting from bottled water transportation and improves the safety and hygiene of providing drinking water.

- Evaluate alternatives to the disposal of high intensity discharge bulbs. As a result, a vendor was identified that accepted the bulbs free of charge.

- Evaluate opportunities to cut waste generation. The Nuclear Engineering Division (NE) evaluated 55 activities and identified two opportunities for improvement to save water and energy.

- Evaluate opportunities to cut power use. The NE division identified two opportunities for improvements to save energy.

- Evaluate opportunities to eliminate off-site environmental impacts due to releases. The NE division did not identify any opportunities for improvements in this area.

3.4.5.2. Solid Waste Recycling Program

Argonne's comprehensive solid waste recycling program effectively recycles/reduces a wide range of materials. Many of the recycling activities result in significant savings for Argonne. For example, Argonne received approximately $67,000 for recycled mixed office paper and scrap metal. Other material that is recycled represents cost avoidance for Argonne; that is, Argonne does not pay for disposal of the material. Table 3.1 presents a summary of the results for 2012.

Argonne continues to utilize programs, such as the Argonne Property Excess System (APES) and Freecycle, which allow employees and contractors to minimize waste and reuse available materials. The APES program was developed to assist Argonne employees in recycling and reusing surplus equipment, supplies, and materials by promoting the availability or need for items via the Argonne email system. Freecycle allows employees to post items (for example, equipment, furniture, and supplies) that can be transferred for use elsewhere at Argonne. Also, the Argonne Chemical Management System is used so that surplus chemicals can be used rather than purchasing new chemicals.

TABLE 3.1

Recycled Materials, 2012

Material	Amount Recycled (tons)
Mixed office paper	30
Aluminum (70%), steel (10%), glass (10%), and plastic (10%)	86
Asphalt, concrete, and construction debris	223
Scrap metal	369
Computer components (PCs)	23
Computer monitors	274
Toner cartridges	5.3
Batteries	0.2
Engine lubricating oils	7.9
Fluorescent lightbulbs	0.6
Lead/acid batteries	1.3
Transparencies	0.01

3.4.6. Employee/Community Awareness

Argonne conducts a number of activities focused on educating and informing both its employees and the public on the status of environmental programs and efforts to promote an environmental awareness. One example is providing information on conserving energy and promoting energy efficiency.

Argonne celebrated Earth Day on April 24, 2012. The activities were organized and coordinated by the Argonne Waste Minimization/Pollution Prevention Committee and were held in the Argonne cafeteria. The activities included posters and handouts about energy and water research and conservation, information on Argonne's Green Ride Connect, bikeshare, bike-to-work and garden plot programs, a poster on P2 program accomplishments, a raffle of a rain barrel, information on native plants and the importance of trees in our environment, and information on invasive species. A collection of Argonne employees' hybrid cars was on display in the cafeteria parking lot.

The Argonne Communications, Education and Public Affairs (CEPA) organization builds and maintains trust within one of Argonne's key stakeholders: the community. Staff keeps Argonne's neighbors apprised of Argonne and its activities through the following activities:

- Community Leaders Round Table – Elected and appointed leaders of public and private community organizations meet quarterly for an informal update on Argonne activities that affect the surrounding communities.

- Community Update Newsletter – Issued periodically, this newsletter contains brief articles about people, discoveries, and developments at Argonne and is mailed to about 50,000 households surrounding Argonne.

- "Argonne OutLoud" – This public lecture series highlights the cutting-edge research taking place at Argonne and topics of interest to the community at large. Lectures are free and open to the public. Advance registration is required.

- *Argonne Now* – Issued biannually, this science publication features stories about research and breakthroughs at Argonne and what it means for our everyday lives. It includes news, interviews with scientists and engineers, op-ed pieces about the challenges facing researchers today, and more. The mailing list includes members of Congress, city and state governments, universities, and community members. Interested parties can sign themselves up at http://www.anl.gov/subscribe.

- Tours – Each year, there are dozens of tours of Argonne's grounds and scientific facilities for college, business, professional, or community groups.

- Argonne Speakers Bureau – Argonne provides community and business groups with speakers about a variety of topics related to Argonne activities.

In addition to these services, Argonne maintains a public website (www.anl.gov) which contains environmental information including: the Argonne environmental policy, the Site Environmental Report (SER) and Summary SER, fact sheets on the monitoring program, and other current environmental information.

3.5. Awards

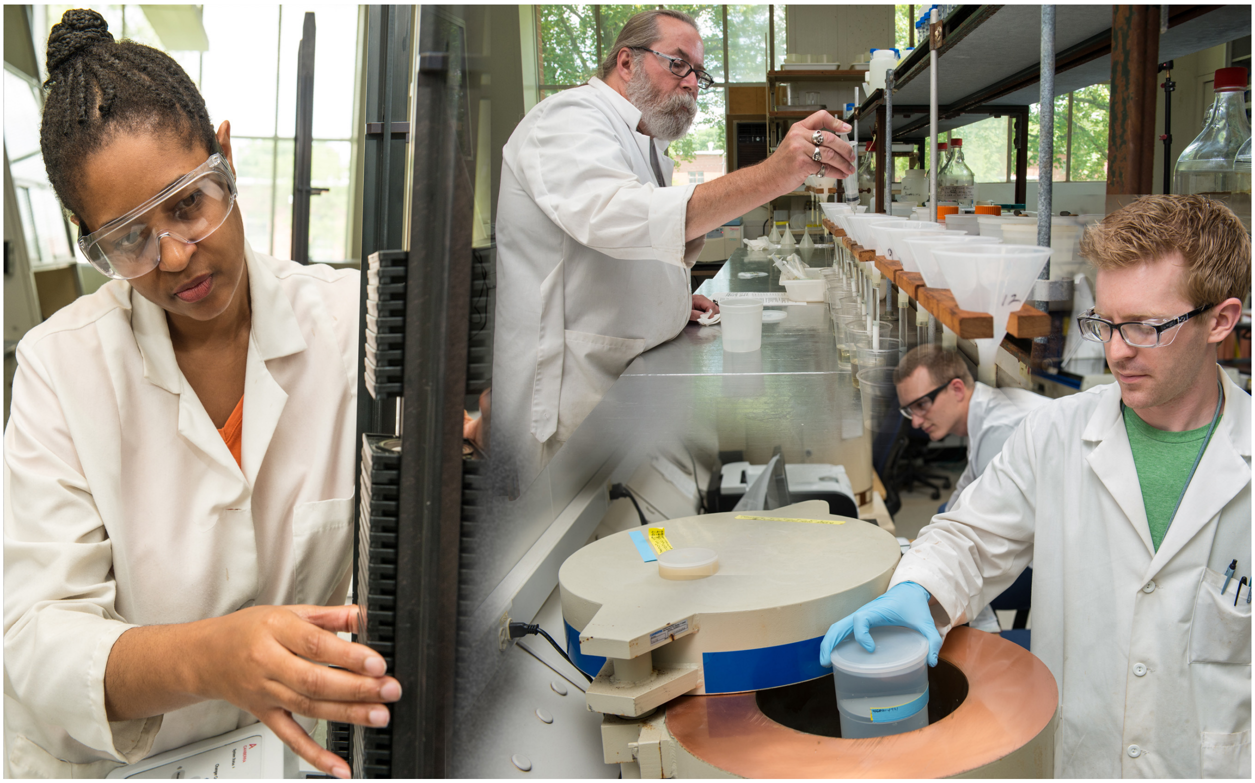
Argonne's Pollution Prevention and Sustainability Programs received the following awards in 2012:

- 2012 Federal Energy and Water Management Award – Better Buildings: Building 438 was built in 1996 and contains office space and laboratories. It was selected for high performance modifications including water and energy saving modifications. Building 438's high performance modifications include upgrades to lighting systems, upgrades to plumbing fixtures; and the inclusion of a heat recovery system. T-12 fluorescent lighting was replaced with light-emitting diode (LED) fixtures that work with occupancy sensors. This upgrade provides a 60 percent reduction in lighting energy consumption, saving 77,107 kWh of energy and $4,050 per year. Restroom fixtures were replaced with high-efficiency sinks and urinals, reducing water consumption by 49,150 gallons — an annual savings of $130. The most innovative improvement is the use of waste heat generated by the Advanced Photon

Source's scientific tools and instruments to pre-heat outdoor ventilation air, resulting in savings of approximately 125 million Btu of energy and a savings of $575 per year. Building 438 has achieved 24% energy savings, based on the building's original design model. The savings were achieved from the installation of LED lighting and occupancy sensors installed in 2011, as compared to FY 2010 (9% savings) and from APS Heat Recovery (15%).

- 2012 Department of Energy Sustainability Awards – Outstanding Sustainability Projects and Practices: During the summer of 2011, Argonne National Laboratory developed a new program for middle school teachers — a Sustainability Workshop. The subject of sustainability has a very broad multidisciplinary appeal for teachers at this level. Also, it fosters considerable community outreach and links well to many local initiatives and resources. With a strong field of Argonne scientists, key topics were presented to the teachers such as Global Warming & Climate Disruption; the Benefits and Risks of Common Energy Sources; Urban Planning & Land Use; and Transportation: All Electric, Plug-in Hybrids, and Biofuels. The fruits of this Workshop included teacher-developed materials, artifacts, and lesson plans that were further developed, tested, and showcased on Argonne's Greenlab Initiative website and promoted in FY2012. The first workshop was conducted from August 8–10, 2011. Twelve middle school teachers participated in five seminars, two tours, and several hands-on lab activities that focused on climate change, traditional and alternative energy production, transportation, and resource sustainability.

4. ENVIRONMENTAL RADIOLOGICAL PROGRAM INFORMATION



4. ENVIRONMENTAL RADIOLOGICAL PROGRAM INFORMATION

4.1. Description of Monitoring Program

The radioactivity of the environment around Argonne in 2012 was determined by measuring the radionuclide concentrations in the air, surface water, subsurface water, and sediment as well as by measuring the external photon penetrating radiation exposure. Sample collections and measurements were made on-site, at the site perimeter, and off-site for comparative purposes.

Because radioactivity is primarily transported by air and water, the sample collection program concentrates on these media. In addition, samples of materials from the Sawmill Creek streambed are analyzed. The program follows the guidance provided in the DOE Environmental Regulatory Guide.[4] The results of radioactivity measurements are expressed in terms of pCi/L for water, fCi/m^3 for air, and pCi/g or fCi/g for bottom sediment. Penetrating radiation measurements are reported in units of mrem/yr, and population dose is reported in units of person-rems.

DOE has provided guidance[5] for effective dose equivalent calculations for members of the public based on International Commission on Radiological Protection (ICRP) Publications 60 and 101.[6,7] Those procedures have been used in preparing this report. The methodology requires that three components be calculated: (1) the committed effective dose equivalent (CEDE) from all sources of ingestion, (2) the CEDE from inhalation, and (3) the direct effective dose equivalent from external radiation. These three components were summed for comparison with the DOE effective dose equivalent limits for environmental exposure. To ensure that at least 90% of the total CEDE is accounted for, the DOE guidance requires that sufficient data on exposure to radionuclide sources be available. For 2012, approximately 97% of the samples that were scheduled were collected. Dry wells, dry surface water locations, or equipment failures accounted for the samples that could not be collected. The primary radiation dose limit for members of the public is 100 mrem/yr. The effective dose equivalents for members of the public from all routine DOE operations (natural background and medical exposures excluded) shall not exceed 100 mrem/yr and must adhere to the as low as reasonably achievable (ALARA) process or be as far below the limits as is practical, taking into account social, economic, technical, practical, and public policy considerations. Routine DOE operations are normally planned operations and exclude actual or potential accidental or unplanned releases.

The measured or calculated environmental radionuclide concentrations were converted to a 50-year CEDE with the use of the CEDE conversion factors[8] and were compared with the annual dose limits for uncontrolled areas. The CEDEs were calculated from the DOE Derived Concentration Standards (DCSs)[5] for members of the public on the basis of a radiation dose of 100 mrem/yr. The numerical values of the CEDE conversion factors used in this report are provided later in this chapter (Table 4.25). Occasionally, other standards are used, and their sources are identified in the text.

4.2. Air

The radioactive content of particles in the air was determined by collecting and analyzing air filter samples. The sampling locations are shown in Figures 1.1 and 1.2. Argonne uses continuously operating air samplers to collect samples for the measurement of concentrations of airborne particles contaminated by radionuclides. Currently, nonradiological air contaminants in ambient air are not monitored. Samples are collected at the site perimeter to determine whether a statistically significant difference exists between perimeter measurements and measurements taken from samples collected at various off-site locations. The off-site samples establish the local background concentrations of naturally occurring or ubiquitous man-made radionuclides, such as from nuclear weapons testing fallout. Higher levels of radioactivity in the air measured at the site perimeter may indicate radioactivity releases from Argonne, provided that the perimeter sample results are greater than the background sample results by an amount greater than the relative error of the measurement. The relative error is a result of natural variation in background concentrations as well as sampling and measurement error. This relative error is typically 5 to 20% of the measurement value for most of the analyses, but approaches 100% at values near the detection limit of the instrument.

Airborne particle samples for measurement of total alpha, total beta, and gamma-ray emitters are collected continuously at 11 perimeter locations and at 4 off-site locations on glass fiber filter media. Average flow rates on the air samplers are about 65 m^3/h (2,295 ft^3/h). Filters are changed weekly. Argonne staff members change the filters on perimeter samplers and the filters on off-site samplers are changed and mailed to Argonne by cooperating local agencies. The sampler air flow rates are recalibrated annually and the units are serviced as needed.

Each air filter sample collected for alpha, beta, and gamma-ray analyses is cut in half. Half of each sample for any calendar week is combined with all other perimeter samples from that week and packaged for gamma-ray spectrometry. A similar package is prepared for the off-site filters for each week. A 5-cm (2-in.) circle is cut from the other half of the filter, mounted in a 5-cm (2-in.) low-lip stainless-steel planchet, and analyzed to determine alpha and beta activity. The remainder of the filter is saved.

Table 4.1 summarizes the monthly total alpha and beta activities for the individual weekly air filter sample analyses. These measurements were made in low-background gas-flow proportional counters and the counting efficiencies used to convert counting rates to disintegration rates were those measured for a 0.30-MeV beta and a 5.5-MeV alpha on filter paper. The results were obtained by measuring the samples at least four days after they were collected to avoid counting the natural activity due to short-lived radon and thoron decay products. This activity is normally present in air and disappears within four days by radioactive decay.

The average concentrations of gamma-ray emitters, as determined by gamma-ray spectrometry performed on composite weekly samples, are given in Table 4.2. The gamma-ray detector is a shielded germanium diode calibrated for each gamma-ray-emitting nuclide measured.

TABLE 4.1

Total Alpha and Beta Activities in Air-Filter Samples, 2012
(Concentrations in fCi/m^3)

			Alpha Activity			Beta Activity		
Month	Location	No. of Samples	Avg.	Min.	Max.	Avg.	Min.	Max.
January	Perimeter	44	1.90	0.91	3.30	32.18	22.37	48.60
	Off-Site	16	2.20	< 0.10	3.92	24.85	< 1.00	39.42
February	Perimeter	55	1.25	0.57	2.53	24.18	14.94	35.01
	Off-Site	17	1.20	0.40	2.78	19.70	9.67	28.80
March	Perimeter	44	1.77	0.91	2.77	22.88	13.59	33.62
	Off-Site	16	1.85	0.70	3.75	18.87	9.45	29.84
April	Perimeter	44	1.63	0.67	2.97	20.09	10.76	29.48
	Off-Site	14	1.59	0.67	2.53	16.10	10.71	21.92
May	Perimeter	55	1.56	0.24	2.68	19.48	2.46	31.46
	Off-Site	18	1.46	0.44	2.46	16.88	6.21	27.72
June	Perimeter	44	1.70	0.86	6.35	20.33	13.59	26.73
	Off-Site	15	1.23	0.81	1.67	18.84	10.89	24.93
July	Perimeter	40	2.04	0.68	3.83	25.13	9.00	37.98
	Off-Site	15	2.12	1.09	4.03	24.87	19.13	34.74
August	Perimeter	54	1.84	0.71	3.02	25.65	15.03	45.45
	Off-Site	17	1.64	0.89	2.96	22.62	10.26	35.96
September	Perimeter	42	1.50	0.44	2.40	23.96	10.53	38.66
	Off-Site	14	1.31	0.63	2.26	22.08	15.84	27.27
October	Perimeter	55	1.65	0.87	2.93	26.10	17.15	39.02
	Off-Site	17	1.52	0.72	2.70	19.84	14.36	27.59
November	Perimeter	33	2.97	0.99	6.62	36.93	15.30	69.75
	Off-Site	14	2.81	0.57	5.27	36.27	16.70	70.65
December	Perimeter	33	2.74	1.23	5.58	40.59	25.97	69.30
	Off-Site	10	2.90	2.22	4.04	33.33	22.32	46.80
Annual	Perimeter	543	1.81 ± 0.40	0.24	6.62	25.77 ± 0.90	2.46	69.75
Summary	Off-Site	183	1.77 ± 0.40	< 0.10	5.27	22.40 ± 0.90	< 1.00	70.65

TABLE 4.2

Gamma-Ray Activity in Air-Filter Samples, 2012
(Concentrations in fCi/m^3)

Month	Location	Beryllium-7	Lead-210
January	Perimeter	114	41
	Off-Site	69	21
February	Perimeter	104	29
	Off-Site	69	16
March	Perimeter	145	16
	Off-Site	103	14
April	Perimeter	166	23
	Off-Site	106	11
May	Perimeter	197	21
	Off-Site	130	12
June	Perimeter	179	22
	Off-Site	119	13
July	Perimeter	143	24
	Off-Site	117	19
August	Perimeter	156	32
	Off-Site	104	19
September	Perimeter	128	27
	Off-Site	93	16
October	Perimeter	109	32
	Off-Site	68	17
November	Perimeter	119	47
	Off-Site	81	30
December	Perimeter	91	52
	Off-Site	61	28
Annual	Perimeter	139	29
Summary	Off-Site	94	18
Dose	Perimeter	(0.00015)	(0.85)
(mrem)	Off-Site	(0.00010)	(0.53)

The gamma-ray emitters listed in Table 4.2 are those that have been present in the air during past years and are of natural origin. The beryllium-7 concentration usually increases in the spring, which indicates its stratospheric origin. The concentration of lead-210 in the air is due to the radioactive decay of gaseous radon-222 and is similar to the concentration last year.

The annual average alpha and beta activities since 2000 are displayed in Figure 4.1. Figure 4.2 presents the annual average concentrations of the two major gamma-ray-emitting radionuclides in air. The changes in the beryllium-7 air concentrations have been observed worldwide by the DOE Environmental Measurements Laboratory's Surface Air Sampling Program and are attributed to changes in solar activity.[10]

The major airborne effluents released at Argonne during 2012 are listed by location in Table 4.3. Short-lived neutron activation products were emitted from the LINAC, and the APS. In addition to the radionuclides listed in Table 4.3, several other fission products also were released in millicurie or smaller amounts. Air emissions from areas that have a probability of releasing measurable concentrations of radionuclides are calculated. The results of these measurements are used to estimate the annual off-site dose using the required EPA CAP-88 (Clean Air Act Assessment Package-1988)[9] atmospheric dispersion computer code and dose conversion method.

Phytoremediation is being performed in the 317/319 Area to complete the cleanup of the groundwater in the area, which was contaminated in the past by the disposal of liquid wastes to the soil in French drains. Phytoremediation is a natural process by which woody and herbaceous plants extract pore water and entrained chemical substances from subsurface soil, degrade volatile organic constituents, and transpire water vapor to the atmosphere. The system consists of shallow-rooted willow and special deep-rooted poplar trees. Approximately 800 poplar trees were planted in the fall of 1999. In 2003, approximately 200 willow trees were planted to expand the system near the French drains.

One of the groundwater contaminants in the 317/319 Area is hydrogen-3, as tritiated water. The phytoremediation process translocates the hydrogen-3 from the groundwater to the air as water vapor. Since the hydrogen-3 is released over an area of approximately 2 ha (5.5 acres), traditional point source monitoring for airborne hydrogen-3 water vapor is of little value to determine the quantity of hydrogen-3 released to the air. The annual inventory of hydrogen-3 released to the air can be estimated from the hydrogen-3 content of the groundwater and the extraction rate at which various aged trees remove groundwater. On the basis of the age and type of tree, estimates are available on the average evapotranspiration rate of groundwater per tree per month of the growing season. For this estimate, it is assumed that all of the groundwater that is extracted is transpired.

Quarterly monitoring is conducted at the 13 wells that are within the phytoremediation plantation. The average hydrogen-3 concentration for 2012 for all the wells was 245 pCi/L. The estimated annual amount of hydrogen-3 released is then the product of the annual volume of water released for all 800 trees multiplied by the hydrogen-3 concentration in the groundwater. For 2012, the estimated total hydrogen-3 released was 0.004 Ci. Applying the CAP-88 code,[9] an

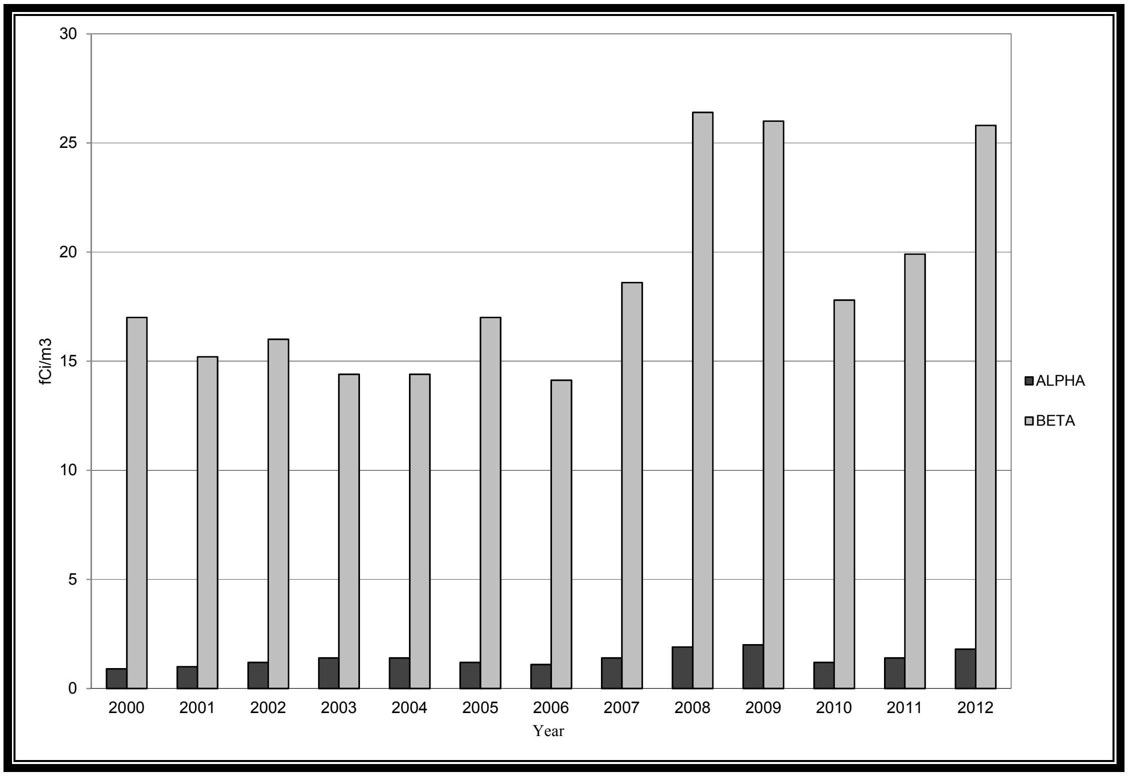


FIGURE 4.1 Comparison of Total Alpha and Beta Activities in Air Filter Samples, 2000 to 2012

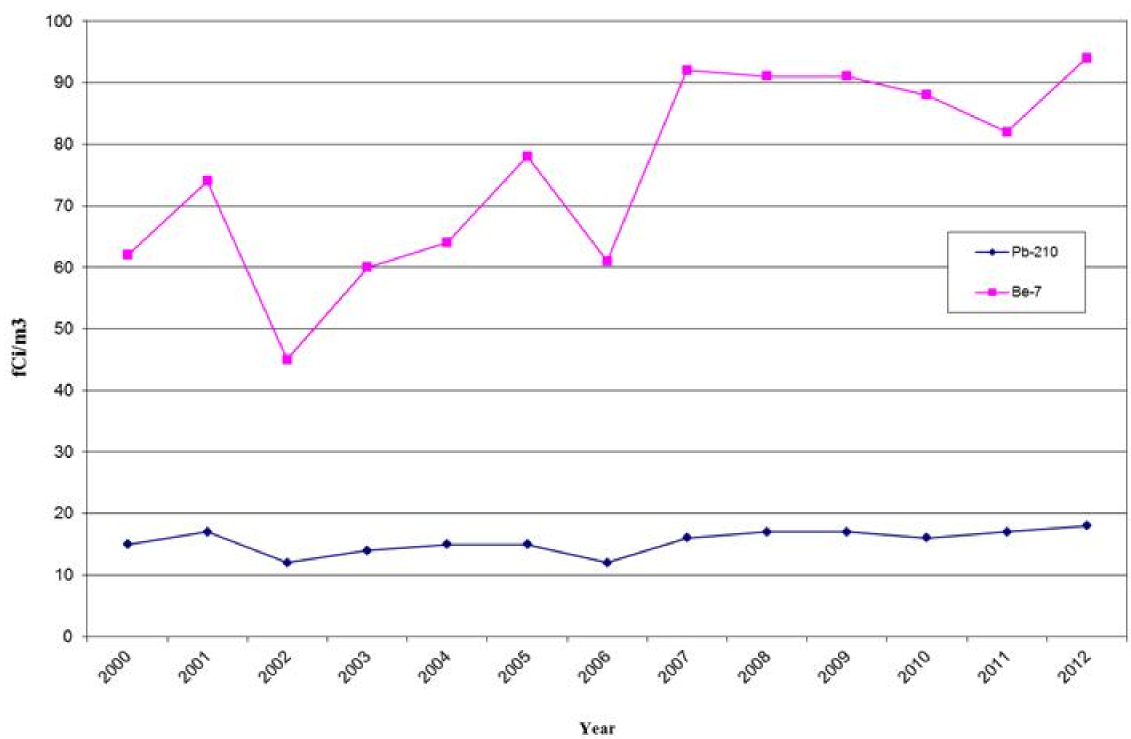


FIGURE 4.2 Comparison of Gamma-Ray Activity in Air Filter Samples, 2000 to 2012

TABLE 4.3

Summary of Airborne Radioactive Emissions from Argonne Facilities, 2012

Building	Nuclide	Half-Life	Amount Released (Ci)	Amount Released (Bq)
200	Radon-220	56 s	30	1.1×10^{12}
203 (CARIBU)	Xenon-138	14 min	0.1	3.7×10^{9}
211 (LINAC)	Hydrogen-3	12.3 yr	6.6×10^{-8}	2.4×10^{3}
	Beryllium-7	53 day	1.2×10^{-6}	4.4×10^{4}
	Carbon-11	20 min	4.2×10^{-2}	1.6×10^{9}
	Nitrogen-13	10 min	39.6	1.5×10^{12}
	Oxygen-15	122 s	1.9	7.0×10^{10}
	Chlorine-38	37 min	1.2×10^{-3}	4.4×10^{7}
	Chlorine-39	56 min	2.6×10^{-2}	9.6×10^{8}
212 (AGHCF and DL114)	Hydrogen-3	12.3 yr	0.1	3.7×10^{9}
	Strontium-90	28.8 yr	1.4×10^{-10}	5.8
	Antimony-125	2.7 yr	1.5×10^{-8}	5.6×10^{2}
	Iodine-125	60 days	1.5×10^{-8}	5.6×10^{2}
	Americium-241	432.7 yr	6.3×10^{-12}	2.3×10^{-1}
366 (AWA)	Nitrogen-13	10 min	6.4×10^{-10}	2.4×10^{1}
	Chlorine-39	56 min	4.2×10^{-12}	1.6×10^{-1}
	Argon-41	1.8 hr	2.6×10^{-13}	9.6×10^{-3}
411/415 (APS)	Carbon-11	20 min	0.6	2.2×10^{10}
	Nitrogen-13	10 min	28.0	1.0×10^{12}
	Oxygen-15	122 s	3.0	1.1×10^{11}

estimate of the annual dose to the maximally exposed individual was 0.00000002 mrem. This estimated dose is extremely small compared with the 10-mrem annual dose limit of NESHAP.

4.3. Surface Water

All water samples collected in the radiological monitoring program were acidified to 0.1N with nitric acid and filtered immediately after collection except for those analyzed for hydrogen-3. Water samples analyzed for hydrogen-3 are not acidified. Total nonvolatile alpha and beta activities were determined by counting the residue remaining after evaporation of the water and then applying weight-dependent counting efficiency corrections determined for plutonium-239 (for alpha activity) and thallium-204 (for beta activity) to obtain disintegration rates. Hydrogen-3 was measured from a separate aliquot. This activity does not appear in the results for total nonvolatile beta activity. Analyses for the radionuclides were performed by specific radiochemical separations followed by appropriate counting. One-liter aliquots were used for all analyses except for hydrogen-3 and the transuranium nuclides. Hydrogen-3 analyses were performed by liquid scintillation counting of 9 mL (0.3 oz) of a distilled sample in a nonhazardous cocktail. Analyses for transuranium nuclides were performed on 10-L (3-gal) samples with chemical separation methods followed by alpha spectrometry. Plutonium-242 was used to determine the yields of plutonium and neptunium, which were separated from the sample together. A group separation of a fraction containing the transplutonium elements was monitored for recovery with an americium-243 tracer. Isotopic uranium concentrations were determined by alpha spectrometry by using uranium-232 as an isotopic tracer.

Liquid wastewater from buildings or facilities that use or process radioactive materials is collected in retention tanks. When a tank is full, it is sampled and analyzed for alpha and beta radioactivity. If the radioactivity exceeds the release limits, the tank is processed as radioactive waste. The release limits are based on the DCSs for plutonium-239 (0.03 pCi/mL) for alpha activity and for strontium-90 (1.0 pCi/mL) for beta activity. These radionuclides were selected because of their potential for release and their conservative allowable limits in the environment. If the radioactivity is below the release limits, the wastewater is conveyed to the LWTP in dedicated pipes to waste storage tanks. The effluent monitoring program documents that no liquid releases above the DCSs have occurred and reinforces demonstration of compliance with the use of the best available technology (BAT) as required by DOE Order 458.1.[5]

Another component of the radiological effluent monitoring program is the radiological analysis of the main water treatment plant discharge (Outfall 001). Metals have also been analyzed at this location for a number of years (see Table 5.7). The same radiological constituents that are determined in Sawmill Creek are also analyzed at this location. Samples are collected daily and then equal daily portions are combined to produce a weekly composite that is analyzed to obtain an average weekly concentration. Table 4.4 gives the radiological results for 2012.

Analysis of the Argonne domestic water, which is obtained from Lake Michigan, indicates the presence of strontium-90 at about 0.3 pCi/L. The concentrations are well below the DOE limits. These findings confirmed Argonne compliance with DOE Order 458.1 for use of BAT for releases of liquid effluents. To estimate the total annual quantity of each radionuclide released to the environment, the product of the annual average concentration and the annual volume of water discharged (8.34×10^8 L) is computed. These results are given in Table 4.5.

Treated Argonne wastewater is discharged into Sawmill Creek (Location 7M in Figure 1.1). The creek runs through the Argonne grounds, drains surface water from much of the site, and flows into the Des Plaines River about 500 m (1,600 ft) downstream from the Argonne wastewater outfall. Sawmill Creek was sampled upstream from the Argonne site and downstream from the wastewater discharge point to determine whether radioactivity was added to the stream by Argonne wastewater or surface drainage. The sampling locations are shown in Figure 1.1. Daily samples were collected below the wastewater outfall. Equal portions of the daily samples collected each week were combined and analyzed to obtain an average weekly concentration. Grab samples were collected upstream of the site monthly and analyzed for the same radionuclides measured in the below-outfall samples.

TABLE 4.4

Radionuclides in Effluents from the Argonne Wastewater Treatment Plant, 2012

		Concentrations in pCi/L			Dose (mrem)		
Activity	No. of Samples	Avg.	Min.	Max.	Avg	Min.	Max.
Alpha	52	0.73	0.03	1.60	–[a]	–	–
Beta	52	15.83	4.38	24.80	–	–	–
Hydrogen-3	52	< 100	< 100	124	< 0.0053	< 0.0053	0.0066
Strontium-90	52	0.32	0.24	0.45	0.029	0.022	0.041
Cesium-137	52	< 2.0	< 2.0	< 2.0	< 0.066	< 0.066	< 0.066
Uranium-234	52	0.269	0.097	0.602	0.040	0.014	0.088
Uranium-238	52	0.231	0.064	0.519	0.031	0.009	0.070
Neptunium-237	52	0.0015	< 0.0010	0.0066	0.0005	< 0.0003	0.0021
Plutonium-238	52	< 0.0010	< 0.0010	0.0027	< 0.0007	< 0.0007	0.0018
Plutonium-239	52	< 0.0010	< 0.0010	0.0269	< 0.0007	< 0.0007	0.0192
Americium-241	52	< 0.0010	< 0.0010	0.0035	< 0.0006	< 0.0006	0.0021
Curium-242 and/or Californium-252	52	< 0.0010	< 0.0010	0.0057	< 0.0001	< 0.0001	0.0003
Curium-244 and/or Californium-249	52	< 0.0010	< 0.0010	< 0.0010	< 0.0004	< 0.0004	< 0.0004

[a] A dash indicates no CEDEs for alpha and beta.

Table 4.6 gives the annual summaries of the results obtained for Sawmill Creek. Comparison of the results and 95% confidence levels of the averages for the two sampling locations show that the only radionuclide found in the creek water that can be attributed to Argonne operations is hydrogen-3. The hydrogen-3 concentrations are lower, compared to last year, which is due to the completion of CP-5 D&D operations. The concentrations of all these nuclides are low and at a small fraction of DOE concentration limits. In Sawmill Creek, downstream of the Argonne outfall, the annual average concentrations of most measured radionuclides were similar to recent annual averages. All annual averages were well below the applicable DOE standards.

TABLE 4.5

Total Radioactivity Released to Surface Water, 2012

Radionuclide	WTP Outfall (Ci)
Hydrogen-3	0.035
Strontium-90	0.0003
Uranium-234	0.0002
Uranium-238	0.0002
Other transuranics	<0.0001
Total	0.036

On the basis of the results of an earlier stormwater characterization study, two perimeter surface water locations that contained measurable levels of radionuclides were identified. They were south of the 319 Area, Location 7J, and south of the 800 Area Landfill, Location 11D (see Figure 1.1). Samples were scheduled to be collected quarterly and analyzed for hydrogen-3, strontium-90, and gamma-ray emitters at Location 7J and hydrogen-3 at Location 11D. The results are presented in Table 4.7.

TABLE 4.6

Radionuclides in Sawmill Creek Water, 2012

			Concentrations (pCi/L)			Dose (mrem)		
Activity	Location[a]	No. of Samples	Avg.	Min.	Max.	Avg.	Min.	Max.
Alpha	16K	12	1.23	0.40	2.37	–[b]	–	–
(Nonvolatile)	7M	52	0.73	0.05	3.56	–	–	–
Beta	16K	12	5.28	4.17	6.89	–	–	–
(Nonvolatile)	7M	52	10.50	4.95	19.49	–	–	–
Hydrogen-3	16K	12	< 100	< 100	104	< 0.0053	< 0.0053	0.0055
	7M	52	< 100	< 100	163	< 0.0053	< 0.0053	0.0086
Strontium-90	16K	12	< 0.25	< 0.25	< 0.25	< 0.023	< 0.023	< 0.023
	7M	52	< 0.25	< 0.25	0.37	< 0.023	< 0.023	0.033
Cesium-137	16K	12	< 2.0	< 2.0	< 2.0	< 0.066	< 0.066	< 0.066
	7M	52	< 2.0	< 2.0	< 2.0	< 0.066	< 0.066	< 0.066
Uranium-234	16K	12	0.614	0.235	1.019	0.090	0.035	0.150
	7M	52	0.385	0.125	0.908	0.057	0.018	0.133
Uranium-238	16K	12	0.591	0.215	0.901	0.079	0.029	0.122
	7M	52	0.346	0.101	0.823	0.046	0.014	0.110
Neptunium-237	16K	12	0.0023	< 0.0010	0.0093	0.0007	< 0.0003	0.0029
	7M	52	0.0013	< 0.0010	0.0031	0.0004	< 0.0003	0.0010
Plutonium-238	16K	12	< 0.0010	< 0.0010	< 0.0010	< 0.0007	< 0.0007	< 0.0007
	7M	52	< 0.0010	< 0.0010	< 0.0010	< 0.0007	< 0.0007	< 0.0007
Plutonium-239	16K	12	< 0.0010	< 0.0010	0.0016	< 0.0007	< 0.0007	0.0011
	7M	52	< 0.0010	< 0.0010	0.0141	< 0.0007	< 0.0007	0.0099
Americium-241	16K	12	< 0.0010	< 0.0010	0.0019	< 0.0006	< 0.0006	0.0011
	7M	52	< 0.0010	< 0.0010	0.0022	< 0.0006	< 0.0006	0.0013
Curium-242 and/or	16K	12	< 0.0010	< 0.0010	< 0.0010	< 0.0001	< 0.0001	< 0.0001
Californium-252	7M	52	< 0.0010	< 0.0010	0.0013	< 0.0001	< 0.0001	0.0001
Curium-244 and/or	16K	12	< 0.0010	< 0.0010	< 0.0010	< 0.0004	< 0.0004	< 0.0004
Californium-249	7M	52	< 0.0010	< 0.0010	< 0.0010	< 0.0004	< 0.0004	< 0.0004

[a] Location 16K is upstream from the Argonne site, and location 7M is downstream from the Argonne wastewater outfall.

[b] A hyphen indicates no CEDEs for alpha and beta.

TABLE 4.7

Radionuclides in Stormwater Outfalls, 2012
(concentrations in pCi/L)

Date Collected	Location 7J			Location 11D
	Hydrogen-3	Strontium-90	Cesium-137	Hydrogen-3
January 6	< 100	0.34	< 2	< 100
April 2	< 100	0.43	< 2	< 100
August 16	DRY	DRY	DRY	< 100
November 15	< 100	0.30	< 2	< 100

The source of the strontium-90 at Location 7J appears to be past releases of leachate from the 319 Area Landfill. A subsurface barrier wall and leachate collection system were constructed south of the 319 Landfill in November 1995 and became operational in 1996. The final cap was installed in 1999. Since the construction and operation of the leachate collection system and cap, radionuclide concentrations in surface water at Location 7J have decreased substantially.

One of the Argonne waste management locations is within the fenced 398A Area (Location 8J in Figure 1.1). Surface water drainage from this area is collected in a small pond at the south (downgradient) end of the 398A Area. To evaluate whether any radionuclides are being transported by stormwater flow through the 398A Area, quarterly sampling is conducted from the 398A Area pond and analyzed for hydrogen-3 and gamma-ray-emitting radionuclides. All hydrogen-3 results were below the detection limit of 100 pCi/L, and gamma-ray spectrometric analysis detected no radionuclides associated with Argonne activities above the detection limit of 2 pCi/L.

Because Sawmill Creek empties into the Des Plaines River, data about the radioactivity in this river is important in assessing the contribution of Argonne wastewater to environmental radioactivity. The Des Plaines River was sampled twice-a-month downstream and once-a-month upstream of the mouth of Sawmill Creek to determine whether the radioactivity in the creek had any effect on the radioactivity in the river. Table 4.8 gives the annual summaries of the results obtained for these two locations. The average nonvolatile alpha, beta, and uranium concentrations in the river were very similar to past averages and remained in the normal range. Average results were similar above and below the creek for all radionuclides.

4.4. Bottom Sediment

The radioactive content of bottom sediment was measured in Sawmill Creek. A set of sediment samples was collected on September 19 and 20, 2012, from the Sawmill Creek bed, above the creek, at the outfall, and at several locations below the point at which Argonne discharges its treated wastewater (Location 7M in Figure 1.1). Also, a sediment sample was collected at location 16K, upgradient of the entire site. A grab sample technique was used to

TABLE 4.8

Radionuclides in Des Plaines River Water, 2012

Activity	Location[a]	No. of Samples	Concentrations (pCi/L) Avg.	Concentrations (pCi/L) Min.	Concentrations (pCi/L) Max.	Dose (mrem) Avg.	Dose (mrem) Min.	Dose (mrem) Max.
Alpha	A	12	0.95	0.31	1.95	-[b]	-	-
(Nonvolatile)	B	24	1.01	0.10	3.54	-	-	-
Beta	A	12	11.19	8.01	16.29	-	-	-
(Nonvolatile)	B	24	11.46	6.75	17.15	-	-	-
Hydrogen-3	A	12	< 100	< 100	< 100	< 0.0053	< 0.0053	< 0.0053
	B	24	< 100	< 100	< 100	< 0.0053	< 0.0053	< 0.0053
Strontium-90	A	12	< 0.25	< 0.25	0.30	< 0.023	< 0.023	0.027
	B	24	< 0.25	< 0.25	0.30	< 0.023	< 0.023	0.027
Uranium-234	A	12	0.421	< 0.001	0.825	0.062	< 0.001	0.121
	B	24	0.406	0.100	0.794	0.060	0.015	0.117
Uranium-238	A	12	0.403	0.102	0.703	0.054	0.014	0.094
	B	24	0.336	0.097	0.655	0.045	0.013	0.088
Neptunium-237	A	12	0.0016	< 0.0010	0.0023	0.0005	< 0.0003	0.0007
	B	12	0.0015	< 0.0010	0.0032	0.0005	< 0.0003	0.0010
Plutonium-238	A	12	< 0.0010	< 0.0010	0.0016	< 0.0007	< 0.0007	0.0011
	B	12	< 0.0010	< 0.0010	< 0.0010	< 0.0007	< 0.0007	< 0.0007
Plutonium-239	A	12	0.0028	< 0.0010	0.0204	0.0020	< 0.0007	0.0146
	B	12	< 0.0010	< 0.0010	0.0014	< 0.0007	< 0.0007	0.0010
Americium-241	A	12	0.0015	< 0.0010	0.0107	0.0009	< 0.0006	0.0071
	B	12	< 0.0010	< 0.0010	0.0029	< 0.0006	< 0.0006	0.0019
Curium-242 and/or	A	12	< 0.0010	< 0.0010	< 0.0010	< 0.0001	< 0.0001	< 0.0001
Californium-252	B	12	< 0.0010	< 0.0010	0.0018	< 0.0001	< 0.0001	0.0001
Curium-244 and/or	A	12	< 0.0010	< 0.0010	< 0.0010	< 0.0004	< 0.0004	< 0.0004
Californium-249	B	12	< 0.0010	< 0.0010	< 0.0010	< 0.0004	< 0.0004	< 0.0004

[a] Location A, near Willow Springs, is upstream; location B, near Lemont, is downstream from the mouth of Sawmill Creek. See Figure 1.2.

[b] A hyphen indicates no CEDEs for alpha and beta.

obtain bottom sediments. After the drying and grinding, the samples were analyzed by the methods described in prior reports[11] for air filter residues. The plutonium and americium were separated from the same 10-g (0.35-oz) aliquot of sediment. Results are given in terms of the oven-dried (110°C [230°F]) weight.

The results, as listed in Table 4.9, show that the concentrations in the samples collected above the outfall at Location 7M are similar to those of the off-site samples collected in past

TABLE 4.9

Radionuclides in Bottom Sediment, 2012

	Concentration (pCi/g)					Concentration (fCi/g)		
Location	Potassium-40	Cesium-137	Radium-226	Thorium-228	Thorium-232	Plutonium-238	Plutonium-239	Americium-241
Sawmill Creek at 16K	13.70 ± 0.47	< 0.01	0.74 ± 0.04	0.57 ± 0.03	0.47 ± 0.06	0.19 ± 0.26	1.55 ± 0.84	0.17 ± 0.28
Sawmill Creek 25 m above outfall	7.19 ± 0.37	< 0.01	0.42 ± 0.04	0.30 ± 0.02	0.24 ± 0.05	0.34 ± 0.32	1.11 ± 0.59	0.18 ± 0.29
Sawmill Creek at outfall	10.40 ± 0.53	0.02 ± 0.01	0.44 ± 0.04	0.33 ± 0.03	0.27 ± 0.05	0.28 ± 0.35	6.60 ± 1.46	1.42 ± 0.83
Sawmill Creek 50 m below outfall	12.00 ± 0.57	0.03 ± 0.01	0.43 ± 0.04	0.32 ± 0.03	0.26 ± 0.05	0.17 ± 0.25	3.79 ± 1.05	1.46 ± 0.75
Sawmill Creek 100 m below outfall	10.10 ± 0.42	0.04 ± 0.01	0.54 ± 0.04	0.46 ± 0.03	0.37 ± 0.05	0.53 ± 0.40	17.00 ± 2.38	2.72 ± 0.95
Sawmill Creek at Des Plaines River	9.80 ± 0.42	0.03 ± 0.01	0.47 ± 0.04	0.41 ± 0.03	0.35 ± 0.05	0.46 ± 0.38	8.72 ± 1.63	1.89 ± 0.83

years.[11] The plutonium and americium concentrations are elevated below the outfall, which indicates that their origin has been in Argonne wastewater in the past.

4.5. External Penetrating Gamma Radiation

Levels of external penetrating gamma radiation at and in the vicinity of the Argonne site were measured with aluminum oxide thermoluminescent dosimeter (TLD) chips provided and read by a commercial vendor. Dosimeters were exposed at 17 locations at the site boundary and on the site. Readings were also taken at five off-site locations (Figure 1.2) for comparative purposes. In 2011, there were a few changes of on-site TLD locations to better monitor potential radiation sources.

The results are summarized in Tables 4.10 and 4.11, and the site boundary and on-site readings are shown in Figure 4.3. Measurements were taken during the four successive exposure periods shown in the tables, and the results were calculated in terms of annual dose for ease in comparing measurements made for different elapsed times. The uncertainty of the averages given in the tables is the 95% confidence limit calculated from the standard deviation of the average.

The off-site results averaged 58 ± 9 mrem/yr and are lower than last year's off-site average of 96 ± 10 mrem/yr.[12] This decrease is due to an adjustment in the background and the resultant net dose rate. Previously, gross dose measurements had been reported, whereas, net dose measurements are now being reported. To compare boundary results for individual sampling periods, the standard deviation of the 20 individual off-site results is useful. This value is 10 mrem/yr; thus, individual results in the range of 58 ± 20 mrem/yr may be considered to be the average natural background with a 95% probability. No perimeter locations had radiation levels above this range of natural background.

Three TLD locations monitor the radioactive waste processing facilities and storage areas. The annual doses at these locations are above normal background levels. This is due to moving, storing and staging radioactive waste containers in the yards and between buildings of the waste processing facilities. Some waste is repackaged in Building 306 (Location 9H/I). The dose from these operations was above normal background level as waste material was stored outside the south wall of Building 306D. During the first seven months of the year a cask containing waste inside an Intermodal Container was stored in the yard. Storage boxes containing low level radioactive waste material remained in the yard through November. The elevated dose levels in the 398A Area (Location 9J) are from radioactive waste located in the south end of the fenced 398A storage yard. This waste was stored throughout the year in a steel bin behind a concrete shield wall. The radiation levels range from 0.07 mR/hr to 0.1 mR/hr outside the surface of the shield wall resulting in slightly higher radiation dose readings at the south end of the yard. The Building 331 yard (Location 9/10 I) is being used as a staging area to load trucks for shipment off-site. A number of radioactive waste shipments were made from this location during 2012, as reflected by the elevated quarterly doses. Depending on the number of shipments, the dose will vary from quarter to quarter until shipments are curtailed during the winter months.

TABLE 4.10

Environmental Penetrating Radiation at Off-Site Locations, 2012

	Dose Rate (mrem/year) Period of Measurement				
Location	Jan 3 – April 2	April 2 – July 2	July 2 – Oct 1	Oct 1 – Jan 4	Average
Lemont	52	59	63	52	56 ± 6
Oak Brook	58	69	69	64	65 ± 5
Orland Park	67	75	64	71	69 ± 5
Woodridge	52	56	62	53	55 ± 5
Palos Park	41	43	46	51	45 ± 4
Average	54 ± 10	60 ± 12	61 ± 9	60 ± 9	58 ± 9

TABLE 4.11

Environmental Penetrating Radiation at Argonne, 2012

	Dose Rate (mrem/year) Period of Measurement				
Location[a]	Jan 3 – April 2	April 2 – July 2	July 2 – Oct 1	Oct 1 – Jan 4	Average
10G - Guesthouse	39	45	52	51	47 ± 6
12N – Boundary	60	61	60	60	60 ± 0
14E – Boundary	52	48	49	45	48 ± 3
14G - Boundary	59	65	52	53	57 ± 6
14I - Boundary	57	50	56	55	54 ± 3
14L – Boundary	51	58	54	52	54 ± 3
7I – Inside 317	29	32	36	35	33 ± 3
7I - Boundary	45	49	48	53	49 ± 4
8D - Boundary	37	33	39	41	37 ± 4
8H – Boundary	46	57	48	48	50 ± 5
8L – Boundary	48	59	57	56	55 ± 5
9H/I – 50 m E of Building 306	541	500	393	108	385 ± 195
9/10 I – SE of Building 331	886	684	1510	468	887 ± 450
9I – NE of Building 350	41	60	51	49	50 ± 8
9J – SW of 398A Area	112	206	182	167	167 ± 40
9/10 – EF Boundary	57	58	65	66	62 ± 5
110/11 K – Lodging Facilities	43	45	48	44	45 ± 2

[a] See Figure 1.1.

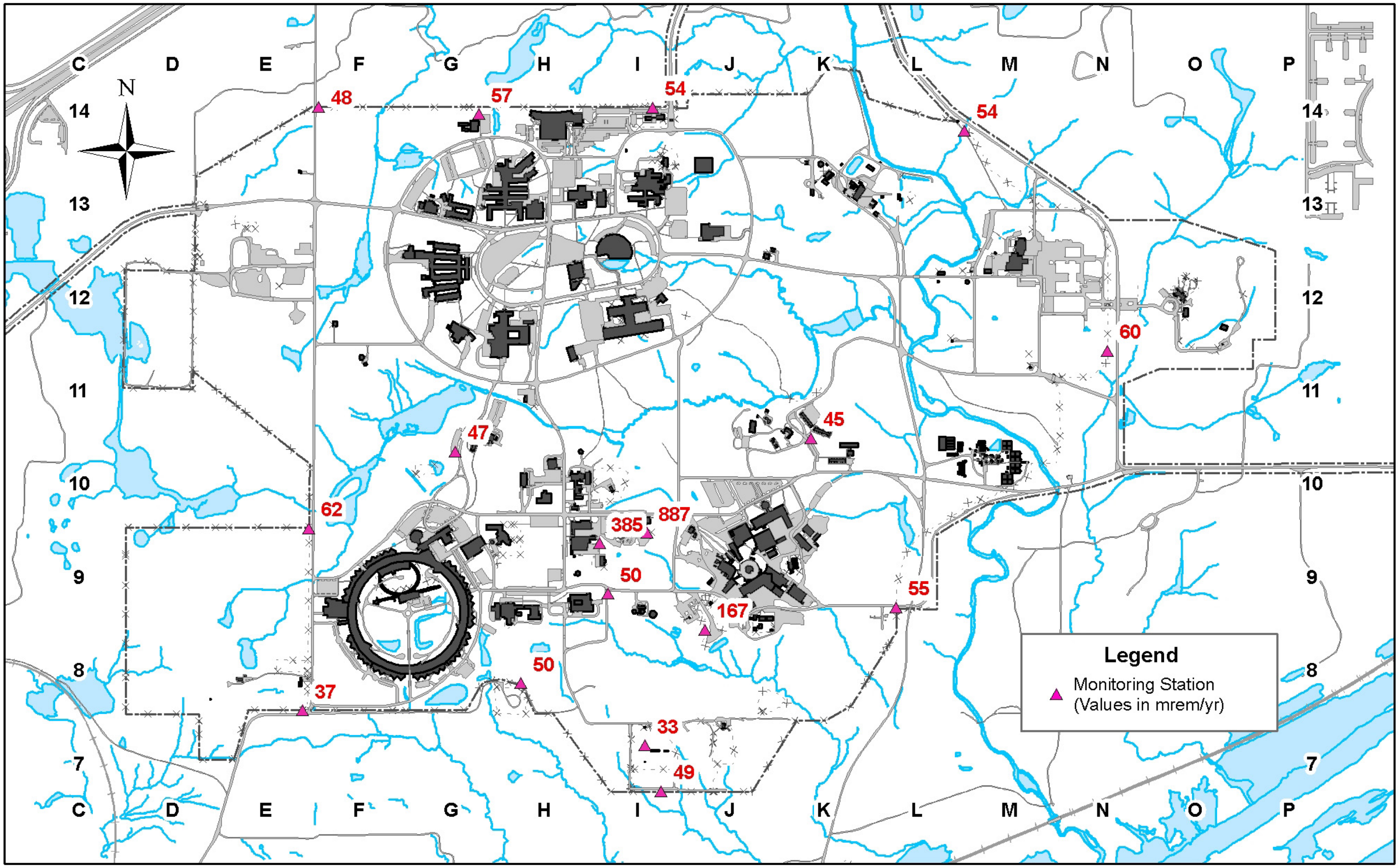


FIGURE 4.3 Penetrating Radiation Measurements at the Argonne Site, 2012

4.6. Compliance with DOE Order 435.1 and 458.1

DOE Order 435.1, “Radioactive Waste Management,” requires that an environmental monitoring and surveillance program be conducted to determine any releases or migration from low-level radioactive waste treatment, storage, or disposal sites. Compliance with these requirements is an integral part of the Argonne site wide monitoring and surveillance program. Waste management operations are covered by relying on the perimeter air monitoring network and monitoring of the liquid effluent streams and Sawmill Creek.

During 2012, Argonne did not release any property containing residual radioactive material for recycle or reuse. All property that contained residual radioactivity, based on the criteria in DOE Order 458.1, was disposed of in an off-site low-level radioactive disposal facility.

4.7. Estimates of Potential Radiation Doses

The potential radiation doses at the site boundary and off the site that could have been received by the public from radioactive materials and radiation leaving the site were calculated. Calculations were performed for three exposure pathways — airborne, water, and direct radiation from external sources. The biota dose was also assessed.

4.7.1. Airborne Pathway

DOE facilities with airborne releases of radioactive materials are subject to 40 CFR Part 61, Subpart H,[13] which requires the use of the EPA’s CAP-88 code[9] to calculate the dose for radionuclides released to the air and to demonstrate compliance with the regulation. The dose limit applicable for 2012 for the air pathway is a 10-mrem/yr effective dose equivalent. The CAP-88 computer code uses a modified Gaussian plume equation to estimate both horizontal and vertical dispersion of radionuclides released to the air from stacks or area sources. For 2012, doses were calculated for hydrogen-3, beryllium-7, carbon-11, nitrogen-13, oxygen-15, chlorine-38, chlorine-39, argon-41, strontium-90, antimony-125, iodine-125, xenon-138, radon-220 plus daughters, and americium-241. The annual releases are those listed in Table 4.3. Separate calculations were performed for each release point. In the past, the wind stability classes had been determined by the temperature differences between the 10-m (33-ft) and 60-m (197-ft) levels. To improve the determination of stability levels, the categories were obtained from daytime measurements of solar radiation and nighttime measurements of the standard deviation of the horizontal wind speed. Doses were calculated for an area extending out to 80 km (50 mi) from Argonne. The population distribution of the 16 compass segments and 10 distance increments given in Table 1.1 was used. The dose rate was calculated at the midpoint of each interval and integrated over the entire area to give the annual population cumulative dose.

Distances from the specific facilities that exhaust radiological airborne emissions (see Table 4.3) to the fence line (perimeter) and nearest resident were determined in the 16 compass segments. Calculations also were performed to evaluate the major airborne pathways — ingestion, inhalation, and immersion — both at the point of maximum perimeter exposure and to the maximally exposed resident. The perimeter and resident doses and the maximum doses are listed, respectively, for releases from Building 200 (Tables 4.12 and 4.13), Building 203 (CARIBU) (Tables 4.14 and 4.15), Building 211 (LINAC) (Tables 4.16 and 4.17), Building 212 (AGHCF and DL-114) (Tables 4.18 and 4.19), Building 350 (NBL) (Tables 4.20 and 4.21), and Building 411/415 (APS) (Tables 4.22 and 4.23). The doses given in these tables are the committed whole body effective dose equivalents.

The doses from each of the CAP-88 dose assessments were combined on the basis of the assumption that the former IPNS facility is the central emission point for the site. The 16 compass directions from the former IPNS facility were established for each perimeter and actual resident location. The individual building assessments were then overlayed on the IPNS grid, and the estimated dose was summed according to which values fell within the IPNS segments. This approach provides an estimated dose to an actual individual and is not just the sum of the maximum doses from the individual building runs.

The highest perimeter dose was in the north direction, with a maximum value of 0.021 mrem/yr (Location 15H in Figure 1.1). Essentially all of this dose can be attributed to air immersion from the Building 200 facility. The maximum perimeter dose is significantly reduced from earlier years due to the termination of operation of the IPNS facility on January 1, 2008.

The full-time resident who would receive the largest annual dose (0.009 mrem/yr), if he or she were outdoors during the entire year, is located approximately 2.7 km (1.7 mi) north of the former IPNS facility. The major contributor to the whole body dose is the air immersion dose from lead-212 (0.005 mrem/yr). If radon-220 plus daughters were excluded from the calculation, the NESHAP reportable dose to the maximally exposed individual would be 0.004 mrem/yr.

The individual doses to the maximally exposed members of the public and the maximum fence line dose are shown in Figure 4.4. Historically, there was a decrease in individual and population doses from 1988 to 1999 due in part to the decrease of radon-220 emissions as a result of the cleanup of the Building 200 M-Wing hot cells. There was, also, an increase from 1999 to 2004 principally due to increased emissions from the IPNS as a result of increased operating time. The decrease since 2007 was the result of the shutdown of IPNS.

The population data in Table 1.1 were used to calculate the cumulative population dose from airborne radioactive effluents from Argonne operations. The results are given in Table 4.24, along with the natural external radiation dose. The natural radiation dose listed is the product of the 80-km (50-mi) population and the natural radiation dose of 311 mrem/yr.[14] It is assumed that this dose is representative of the entire area within an 80-km (50-mi) radius. The population dose resulting from Argonne operations since 2000 is shown in Figure 4.5.

TABLE 4.12

Radiological Airborne Releases from Building 200, 2012

Direction	Distance to Perimeter (m)	Dose[a] (mrem/yr)	Distance to Nearest Resident (m)	Dose[a] (mrem/yr)
N	500	1.4×10^{-2}	1,000	5.1×10^{-3}
NNE	600	1.1×10^{-2}	1,100	4.2×10^{-3}
NE	750	6.5×10^{-3}	2,600	8.7×10^{-4}
ENE	1,700	2.1×10^{-3}	3,100	7.9×10^{-4}
E	2,400	1.5×10^{-3}	3,500	7.1×10^{-4}
ESE	2,200	1.5×10^{-3}	3,600	6.9×10^{-4}
SE	2,100	1.4×10^{-3}	4,000	4.8×10^{-4}
SSE	2,000	1.4×10^{-3}	4,000	4.5×10^{-4}
S	1,500	7.1×10^{-4}	4,000	1.6×10^{-4}
SSW	1,000	4.2×10^{-3}	2,500	9.8×10^{-4}
SW	800	1.0×10^{-2}	2,200	2.3×10^{-3}
WSW	1,100	4.5×10^{-3}	1,500	2.7×10^{-3}
W	750	6.7×10^{-3}	1,500	2.1×10^{-3}
WNW	800	4.0×10^{-3}	1,300	1.8×10^{-3}
NW	600	6.4×10^{-3}	1,100	2.5×10^{-3}
NNW	600	6.9×10^{-3}	800	4.4×10^{-3}

[a] Source term: radon-220 = 30 Ci (plus daughters) small quantities of actinides and fission products

TABLE 4.13

Maximum Perimeter and Individual Doses from Building 200 Air Emissions, 2012 (dose in mrem/yr)

Pathway	Perimeter (500 m N)	Individual (1,000 m N)
Ingestion	4.3×10^{-7}	1.6×10^{-7}
Inhalation	1.4×10^{-2}	5.1×10^{-3}
Air immersion	3.0×10^{-6}	1.1×10^{-6}
Ground surface	1.3×10^{-5}	5.0×10^{-6}
Total	1.4×10^{-2}	5.1×10^{-3}
Radionuclide		
Thallium-208	1.0×10^{-5}	4.1×10^{-6}
Bismuth-212	1.9×10^{-4}	7.1×10^{-5}
Lead-212	1.4×10^{-2}	5.1×10^{-3}
Radon-220	7.5×10^{-9}	2.8×10^{-9}
Others	7.4×10^{-5}	2.5×10^{-5}
Total	1.4×10^{-2}	5.2×10^{-3}

TABLE 4.14

Radiological Airborne Releases from Building 203 (CARIBU), 2012

Direction	Distance to Perimeter (m)	Dose[a] (mrem/yr)	Distance to Nearest Resident (m)	Dose[a] (mrem/yr)
N	175	2.9×10^{-4}	650	4.6×10^{-5}
NNE	200	1.7×10^{-4}	1,250	1.3×10^{-5}
NE	300	1.0×10^{-4}	2,200	4.1×10^{-6}
ENE	1,200	9.8×10^{-6}	2,650	2.6×10^{-6}
E	1,500	7.0×10^{-6}	2,600	2.8×10^{-6}
ESE	2,000	4.3×10^{-6}	3,100	2.1×10^{-6}
SE	1,800	4.4×10^{-6}	3,700	$<1.0 \times 10^{-12}$
SSE	2,000	4.5×10^{-6}	3,200	2.1×10^{-6}
S	1,700	3.3×10^{-6}	3,600	$<1.0 \times 10^{-12}$
SSW	1,800	5.7×10^{-6}	3,500	2.0×10^{-6}
SW	1,100	2.6×10^{-5}	2,300	1.3×10^{-5}
WSW	1,250	9.0×10^{-6}	1,600	6.2×10^{-6}
W	900	1.4×10^{-5}	1,300	8.5×10^{-6}
WNW	600	1.4×10^{-5}	1,000	6.2×10^{-6}
NW	250	1.0×10^{-4}	750	2.2×10^{-5}
NNW	200	1.5×10^{-4}	650	2.8×10^{-5}

[a] Source terms: xenon-138 = 0.12 Ci

TABLE 4.15

Maximum Perimeter and Individual Doses from Building 203 (CARIBU) Air Emissions, 2012 (dose in mrem/yr)

Pathway	Perimeter (175 m N)	Individual (650 m N)
Ingestion	–[a]	–
Inhalation	4.6×10^{-6}	7.3×10^{-7}
Air immersion	2.8×10^{-4}	4.6×10^{-5}
Ground surface	–	–
Total	2.8×10^{-4}	4.6×10^{-5}
Radionuclide		
Xenon-138	2.0×10^{-4}	3.2×10^{-5}
Cesium-138	8.9×10^{-5}	1.4×10^{-5}
Total	2.9×10^{-4}	4.6×10^{-5}

[a] A dash indicates no exposure by this pathway.

TABLE 4.16

Radiological Airborne Releases from Building 211 (LINAC), 2012

Direction	Distance to Perimeter (m)	Dose[a] (mrem/yr)	Distance to Nearest Resident (m)	Dose[a] (mrem/yr)
N	800	5.5×10^{-3}	1,200	2.7×10^{-3}
NNE	1,200	2.5×10^{-3}	1,200	2.5×10^{-3}
NE	1,600	1.2×10^{-3}	2,400	6.2×10^{-4}
ENE	2,000	7.5×10^{-4}	2,800	4.2×10^{-4}
E	2,200	6.5×10^{-4}	3,200	3.5×10^{-4}
ESE	1,700	1.0×10^{-3}	3,200	3.5×10^{-4}
SE	1,800	8.0×10^{-4}	3,400	2.8×10^{-4}
SSE	1,800	9.7×10^{-4}	3,000	4.1×10^{-4}
S	1,300	9.7×10^{-4}	3,000	2.4×10^{-4}
SSW	1,400	1.6×10^{-3}	3,000	4.3×10^{-4}
SW	700	1.7×10^{-2}	1,800	3.7×10^{-3}
WSW	800	3.6×10^{-3}	1,800	9.0×10^{-4}
W	1,200	1.7×10^{-3}	1,400	1.3×10^{-3}
WNW	1,000	1.1×10^{-3}	1,400	6.1×10^{-4}
NW	800	2.3×10^{-3}	1,200	1.7×10^{-3}
NNW	900	2.7×10^{-3}	1,050	2.9×10^{-3}

[a] Source terms: hydrogen-3 = 6.6×10^{-8} Ci; beryllium-7 = 1.2×10^{-6} Ci; carbon-11 = 4.2×10^{-2} Ci; nitrogen-13 = 39.6 Ci; oxygen-15 = 1.9 Ci; chlorine-38 = 1.2×10^{-3} Ci; chlorine-39 = 2.6×10^{-2} Ci

TABLE 4.17

Maximum Perimeter and Individual Doses from Building 211 (LINAC) Air Emissions, 2012 (dose in mrem/yr)

Pathway	Perimeter (700 m SW)	Individual (1,800 m SW)
Ingestion	9.6×10^{-12}	1.8×10^{-12}
Inhalation	4.6×10^{-6}	8.1×10^{-7}
Air immersion	1.8×10^{-2}	3.7×10^{-3}
Ground surface	3.5×10^{-9}	6.8×10^{-10}
Total	1.8×10^{-2}	3.7×10^{-3}
Radionuclide		
Hydrogen-3	7.9×10^{-12}	1.7×10^{-12}
Beryllium-7	3.8×10^{-9}	7.3×10^{-10}
Carbon-11	2.5×10^{-5}	5.3×10^{-6}
Nitrogen-13	1.7×10^{-2}	3.7×10^{-3}
Oxygen-15	8.8×10^{-5}	1.9×10^{-5}
Chlorine-38	1.3×10^{-6}	2.3×10^{-7}
Chlorine-39	2.8×10^{-5}	4.9×10^{-6}
Total	1.8×10^{-2}	3.7×10^{-3}

TABLE 4.18

Radiological Airborne Releases from Building 212 (AGHCF and DL-114), 2012

Direction	Distance to Perimeter (m)	Dose[a] (mrem/yr)	Distance to Nearest Resident (m)	Dose[a] (mrem/yr)
N	800	4.8×10^{-6}	2,000	1.1×10^{-6}
NNE	1,000	3.1×10^{-6}	2,500	7.1×10^{-7}
NE	1,300	1.6×10^{-6}	2,000	8.3×10^{-7}
ENE	1,500	1.2×10^{-6}	2,500	5.1×10^{-7}
E	1,600	1.1×10^{-6}	2,800	4.4×10^{-7}
ESE	1,200	1.7×10^{-6}	2,500	5.3×10^{-7}
SE	1,400	1.1×10^{-6}	3,500	2.7×10^{-7}
SSE	1,400	1.4×10^{-6}	4,500	2.3×10^{-7}
S	1,500	6.6×10^{-7}	5,000	1.1×10^{-7}
SSW	1,600	1.2×10^{-6}	5,000	2.1×10^{-7}
SW	1,400	2.4×10^{-6}	2,400	1.2×10^{-6}
WSW	1,300	1.4×10^{-6}	2,300	5.8×10^{-7}
W	1,700	8.6×10^{-7}	2,200	5.8×10^{-7}
WNW	1,500	5.3×10^{-7}	2,000	3.3×10^{-7}
NW	1,300	1.3×10^{-6}	2,000	6.8×10^{-7}
NNW	1,000	2.0×10^{-6}	2,000	6.8×10^{-7}

[a] Source terms: hydrogen-3 = 0.12 Ci; strontium-90 = 1.4×10^{-10} Ci; antimony-125 = 1.5×10^{-8} Ci; iodine-129 = 1.0×10^{-8} Ci; amercium-241 = 6.3×10^{-12} Ci

TABLE 4.19

Maximum Perimeter and Individual Doses from Building 212 (AGHCF and DL-114) Air Emissions, 2012 (dose in mrem/yr)

Pathway	Perimeter (800 m N)	Individual (2,400 m SW)
Ingestion	1.1×10^{-6}	2.7×10^{-7}
Inhalation	3.7×10^{-6}	9.7×10^{-7}
Air immersion	1.3×10^{-12}	3.1×10^{-13}
Ground surface	–[a]	–
Total	4.8×10^{-6}	1.2×10^{-6}
Radionuclide		
Hydrogen-3	4.8×10^{-6}	1.2×10^{-6}
Strontium-90	$<1.0 \times 10^{-12}$	$<1.0 \times 10^{-12}$
Antimony-125	8.2×10^{-11}	2.0×10^{-11}
Iodine-129	3.6×10^{-10}	5.5×10^{-11}
Amercium-241	$<1.0 \times 10^{-12}$	$<1.0 \times 10^{-12}$
Total	4.8×10^{-6}	1.2×10^{-6}

[a] A dash indicates no exposure by this pathway.

TABLE 4.20

Radiological Airborne Releases from Building 350 (NBL), 2012

Direction	Distance to Perimeter (m)	Dose[a] (mrem/yr)	Distance to Nearest Resident (m)	Dose[a] (mrem/yr)
N	1,700	4.1×10^{-5}	2,200	2.8×10^{-5}
NNE	1,800	3.8×10^{-5}	3,200	1.4×10^{-5}
NE	2,200	2.2×10^{-5}	3,100	1.2×10^{-5}
ENE	2,000	2.3×10^{-5}	3,100	1.1×10^{-5}
E	1,700	3.1×10^{-5}	3,000	1.5×10^{-5}
ESE	900	6.2×10^{-5}	3,000	1.2×10^{-5}
SE	900	6.0×10^{-5}	2,700	1.2×10^{-5}
SSE	700	8.0×10^{-5}	2,700	1.4×10^{-5}
S	600	3.2×10^{-5}	2,700	7.0×10^{-6}
SSW	400	1.1×10^{-4}	2,500	1.6×10^{-5}
SW	600	1.3×10^{-4}	2,700	2.2×10^{-5}
WSW	800	7.8×10^{-5}	2,100	1.8×10^{-5}
W	900	4.0×10^{-5}	2,200	1.4×10^{-5}
WNW	1,000	2.9×10^{-5}	2,100	8.8×10^{-6}
NW	1,900	1.3×10^{-5}	2,400	1.4×10^{-5}
NNW	1,900	2.4×10^{-5}	2,200	1.7×10^{-5}

[a] Source terms: uranium-235 = 4.3×10^{-5} Ci
small quantities of actinides

TABLE 4.21

Maximum Perimeter and Individual Doses
from Building 350 (NBL) Air Emissions, 2012
(dose in mrem/yr)

Pathway	Perimeter (600 m SW)	Individual (2,200 m N)
Ingestion	8.3×10^{-7}	1.8×10^{-7}
Inhalation	1.3×10^{-4}	2.8×10^{-5}
Air immersion	1.0×10^{-9}	2.3×10^{-10}
Ground surface	4.7×10^{-7}	1.0×10^{-7}
Total	1.3×10^{-4}	2.8×10^{-5}
Radionuclide		
Uranium-235	1.3×10^{-4}	2.8×10^{-5}
Total	1.3×10^{-4}	2.8×10^{-5}

TABLE 4.22

Radiological Airborne Releases from Building 411/415 (APS), 2012

Direction	Distance to Perimeter (m)	Dose[a] (mrem/yr)	Distance to Nearest Resident (m)	Dose[a] (mrem/yr)
N	1,500	1.2×10^{-3}	2,000	7.8×10^{-4}
NNE	1,600	1.0×10^{-3}	2,100	6.5×10^{-4}
NE	2,200	4.9×10^{-4}	3,100	2.8×10^{-4}
ENE	2,500	3.5×10^{-4}	3,300	2.3×10^{-4}
E	1,600	7.5×10^{-4}	3,400	2.2×10^{-4}
ESE	1,500	8.4×10^{-4}	3,500	2.2×10^{-4}
SE	400	4.8×10^{-3}	3,000	2.3×10^{-4}
SSE	400	6.0×10^{-3}	3,000	2.8×10^{-4}
S	350	2.8×10^{-3}	2,500	2.1×10^{-4}
SSW	400	5.6×10^{-3}	2,800	3.3×10^{-4}
SW	550	5.9×10^{-3}	3,000	6.7×10^{-4}
WSW	800	2.0×10^{-3}	1,400	8.6×10^{-4}
W	800	1.7×10^{-3}	1,500	7.1×10^{-4}
WNW	500	1.9×10^{-3}	1,400	4.1×10^{-4}
NW	350	5.4×10^{-3}	1,600	6.6×10^{-4}
NNW	1,500	7.4×10^{-4}	2,000	4.7×10^{-4}

[a] Source terms: carbon-11 = 0.6 Ci
nitrogen-13 = 28.0 Ci
oxygen-15 = 3.0 Ci

TABLE 4.23

Maximum Perimeter and Individual Doses from
Building 411/415 (APS) Air Emissions, 2012
(dose in mrem/yr)

Pathway	Perimeter (1,500 m NNW)	Individual (1,400 m WSW)
Ingestion	–[a]	–
Inhalation	2.0×10^{-6}	2.9×10^{-7}
Air immersion	6.0×10^{-3}	8.6×10^{-4}
Ground surface	–	–
Total	6.0×10^{-3}	8.6×10^{-4}
Radionuclide		
Carbon-11	1.7×10^{-4}	2.4×10^{-5}
Nitrogen-13	5.8×10^{-3}	8.3×10^{-4}
Oxygen-15	6.6×10^{-5}	9.4×10^{-6}
Total	6.0×10^{-3}	8.6×10^{-4}

[a] A dash indicates no exposure by this pathway.

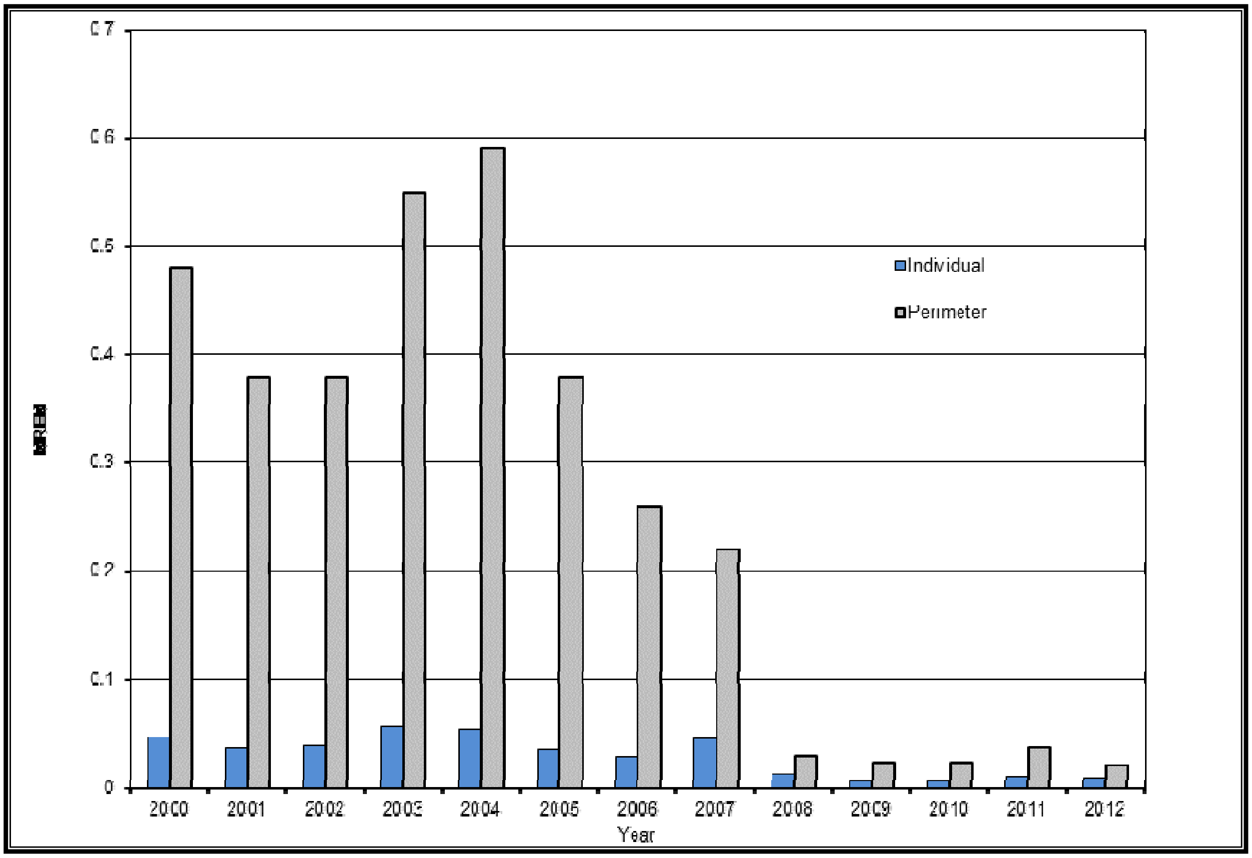


FIGURE 4.4 Individual and Perimeter Doses from Airborne Radioactive Emissions

TABLE 4.24

Population Dose within 80 km (50 mi), 2012

Radionuclide	Person-rem
Carbon-11	<0.01
Nitrogen-13	0.30
Oxygen-15	<0.01
Lead-212	0.28
Bismuth-212	<0.01
Uranium-235	<0.01
Total	0.60
Natural	2.8×10^6

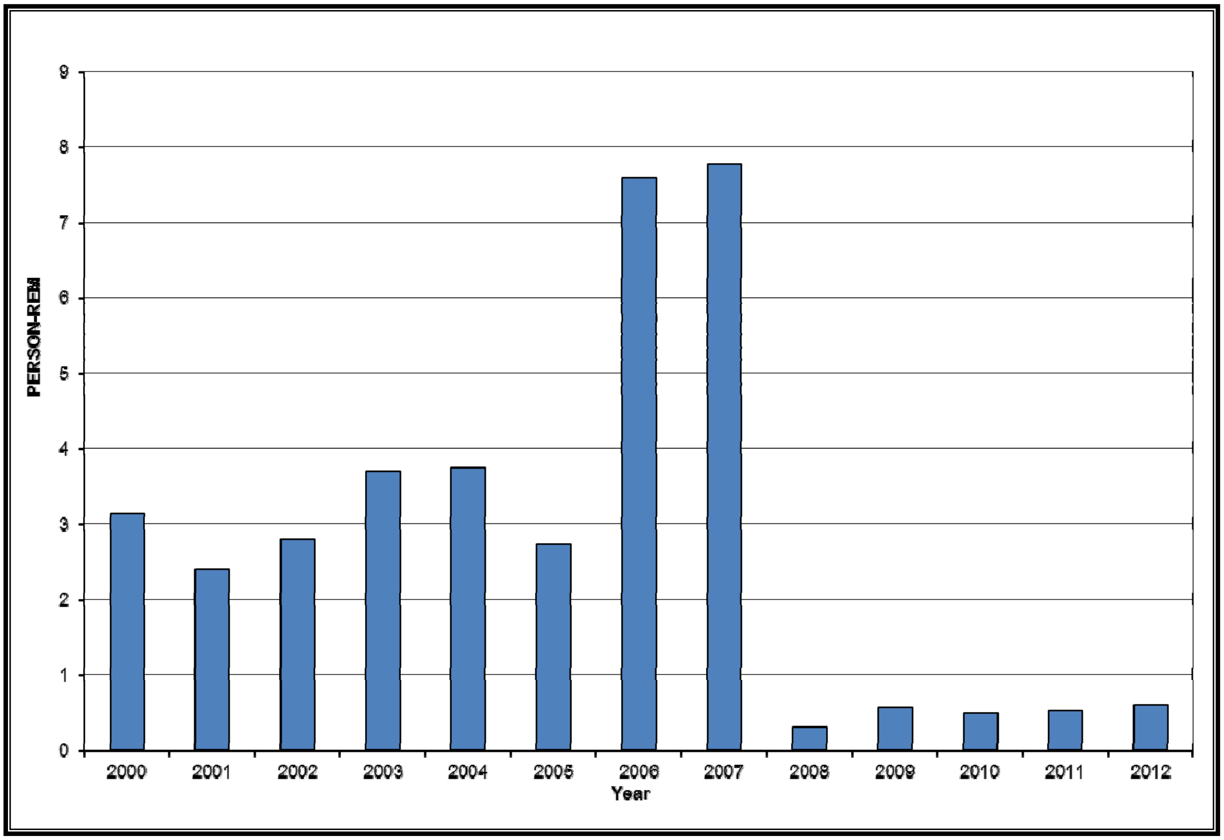


FIGURE 4.5 Population Dose from Airborne Radioactive Emissions

The significant increase in population dose in 2006 and 2007 compared with earlier years is due to a change in the dispersion calculation in Version 3.0 of CAP-88. In the past, Version 1.0 of CAP-88 was used. The change to Version 3.0 involved the replacement of the dispersion section used in Version 1.0 with the methodology from the ICRP.[6,7] Although technically more correct, the effect is to increase the apparent population dose, which is accentuated by a combination of short half-life gases coupled with a large receptor population. This appears to be the case for Argonne. However, the significant decrease in population dose since 2007 is due to the termination of the operation of the IPNS.

The potential radiation exposures by the inhalation pathway also was calculated by the methodology specified in DOE Order 458.1.[5] The total quantity for each radionuclide inhaled, in microcuries (μCi), is calculated by multiplying the annual average air concentrations by the general public breathing rate of 7,300 m^3/yr.[15] This annual intake is then multiplied by the CEDE conversion factor for the appropriate lung retention class.[5] The CEDE conversion factors are in units of rem/μCi; this calculation gives the 50-year CEDE. Table 4.25 lists the applicable CEDE factors.

TABLE 4.25

50-Year Committed Effective Dose Equivalent Conversion Factors (rem/μCi)

Nuclide	Ingestion	Inhalation
Hydrogen-3	4.3×10^{-5}	1.8×10^{-4}
Beryllium-7	–[a]	0.015
Carbon-11	–	4.4×10^{-5}
Strontium-90	0.07	0.14
Cesium-137	0.03	0.015
Lead-210	–	4.0
Radium-226	9.1	–
Thorium-228	–	145
Thorium-230	–	49
Thorium-232	–	86
Uranium-234	0.11	12.5
Uranium-235	0.11	11.4
Uranium-238	0.10	10.5
Neptunium-237	0.25	–
Plutonium-238	0.53	–
Plutonium-239	0.57	169
Americium-241	0.47	–
Curium-242	0.036	–
Curium-244	0.30	–
Californium-249	0.86	–
Californium-252	0.28	–

[a] A dash indicates that a value is not required.

4.7.2. Water Pathway

Following the methodology outlined in DOE Order 458.1,[5] the annual intake of radionuclides (in μCi) ingested with water is obtained by multiplying the concentration of radionuclides in microcuries per milliliter (μCi/mL) by the average annual water consumption of a member of the general public (7.3×10^5 mL). This annual intake is then multiplied by the CEDE conversion factor for ingestion (Table 4.25) to obtain the dose received in that year. This procedure was carried out for all detected radionuclides and the individual results were summed to obtain the total ingestion dose.

The only significant location where radionuclides attributable to Argonne operations could be found in off-site water was Sawmill Creek below the wastewater outfall (see Table 4.6). Although this water is not used for drinking purposes, the 50-year effective dose equivalent was calculated for a hypothetical individual ingesting water at the radionuclide concentrations measured at that location. Those radionuclides added to Sawmill Creek by Argonne wastewater, their net average concentrations in the creek, and the corresponding dose rates (if water at these concentrations was used as the sole water supply by an individual for an entire year) are given in Table 4.26. The dose rates were all well below the standards for the general population. It should

TABLE 4.26

Radionuclide Concentrations and Dose Estimates for Sawmill Creek Water, 2012

Nuclide	Total Released (Ci)	Net Avg. Concentration (pCi/L)	Dose (mrem)
Hydrogen-3	0.03	7	<0.001
Strontium-90	0.0002	0.1	0.005
Plutonium-239	<0.0001	<0.001	<0.001
Americium-241	<0.0001	<0.001	<0.001
Total	0.03		0.005

be emphasized that Sawmill Creek is not used for drinking, swimming, or boating. Inspection of the area shows that there are fish in the stream; however, they do not constitute a significant source of food for any individual. Figure 4.6 is a plot (2000–2012) showing the estimated dose a hypothetical individual would receive if ingesting Sawmill Creek water.

As indicated in Table 4.6, occasional Sawmill Creek samples (fewer than 10%) contained traces of neptunium-237, plutonium-239, americium-241, curium-244, and/or californium-249; however, the averages were only slightly greater than the detection limit. The slightly elevated neptunium-237 results are due to an interference of the spike used during the alpha spectrometric analysis and are not real. The annual dose to an individual consuming water at these concentrations can be calculated with the same method used for those radionuclides more commonly found in creek water. This method of estimation, however, probably overestimates the true dose. Annual doses range from 1×10^{-5} to 4×10^{-8} mrem/yr for these radionuclides.

Sawmill Creek flows into the Des Plaines River. The flow rate of Sawmill Creek (see Section 1.8) is about 0.28 m^3/s (10 ft^3/s). The flow rate of the Des Plaines River in the vicinity of Argonne is about 25 m^3/s (900 ft^3/s). Applying this ratio to the concentration of radionuclides in Sawmill Creek listed in Table 4.28, the dose to a hypothetical individual ingesting water from the Des Plaines River at Lemont would be about 0.00006 mrem/yr. Significant additional dilution occurs farther downstream. Very few people, either directly or indirectly, use the Des Plaines River as a source of drinking water. If 100 people used Des Plaines River water at the hypothetical concentration at Lemont, the estimated population dose would be about 10^{-5} person-rem.

4.7.3. Biota Dose Assessment

DOE Order 458.1[5] requires an evaluation of the dose to aquatic organisms from liquid effluents. The dose limit is 1 rad/day, or 365 rad/yr. The location that could result in the highest dose to aquatic organisms is in Sawmill Creek downstream of the point where Argonne

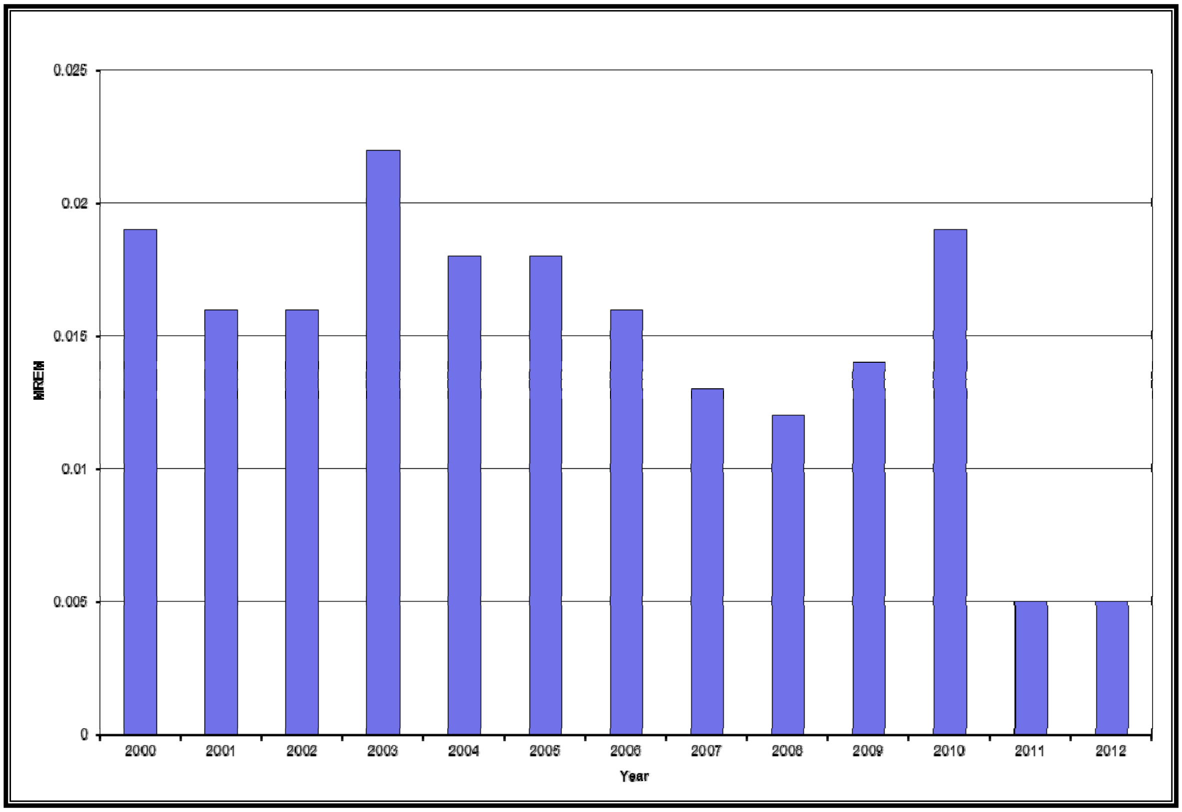


FIGURE 4.6 Comparison of Dose Estimates from Ingestion of Sawmill Creek Water

discharges its treated wastewater. Inspection of the creek at this location indicates the presence of small bluegill and carp. The aquatic dose assessment of these species was conducted by using the DOE Technical Standard, *A Graded Approach for Evaluating Radiation Doses to Aquatic and Terrestrial Biota*.[16] The assessment used the general screening approach which compares maximum water and sediment radionuclide concentrations to biota concentration guides (BCGs). Maximum water concentrations for hydrogen-3, strontium-90, plutonium-239, and americium-241 were obtained from Table 4.6, while maximum sediment concentrations for plutonium-239 and americium-241 were obtained from Table 4.9. Summing the ratios of their respective BCGs for each radionuclide resulted in a ratio of 0.0013 to aquatic biota. This is well below a ratio of one and demonstrates compliance with the limit in DOE Order 458.1.

4.7.4. External Direct Radiation Pathway

The TLD measurements given in Section 4.5 were used to calculate the radiation dose from external sources. At Location 7I, the fence-line dose from Argonne was 49 ± 4 mrem/yr. The off-site average dose was 58 ± 9 mrem/yr.

4.7.5. Dose Summary

The total effective dose equivalent received by off-site residents during 2012 was a combination of the individual doses received through the separate pathways. Radionuclides that contributed through the air pathway are hydrogen-3, beryllium-7, carbon-11, nitrogen-13, oxygen-15, chlorine-38, chlorine-39, argon-41, strontium-90, antimony-125, iodine-125, xenon-138, radon-220 plus daughters, and americium-241. The highest dose from the air pathway was approximately 0.009 mrem/yr to individuals living north of the site if they were outdoors at that location during the entire year. The total annual population dose to the entire area within an 80-km (50-mi) radius was 0.60 person-rem. The dose pathways are presented in Table 4.27 and are compared with the applicable standards.

To receive the hypothetical maximum public dose, an individual would need to live at the point of maximum air and direct radiation exposure and use only water from Sawmill Creek below the Argonne wastewater discharge. This is a very conservative and unlikely situation. To put the hypothetical maximum individual dose from all pathways of 0.015 mrem/yr attributable to Argonne operations into perspective, comparisons can be made with annual average doses (624 mrem) from natural or accepted sources of radiation received by an average American who could be living anywhere in the United States. These values are listed in Table 4.28. These site-related doses are in addition to the background doses. The magnitude of the doses received from Argonne operations is insignificant compared to these sources. Therefore, the monitoring program results establish that the radioactive emissions from Argonne are very low and do not endanger the health or safety of those living in the vicinity of the site.

TABLE 4.27

Summary of the Estimated Dose to a Hypothetical Individual, 2012 (mrem/yr)

Pathway	Argonne Estimate	Applicable Standard
Air total	0.009	10 (EPA)
Water	0.005	4 (EPA)[a]
Direct radiation	0.001	25 (NRC)[b]
Maximum dose	0.015	100 (DOE)

[a] The 4-mrem/yr EPA value is not an applicable standard, since it applies to community water systems.[17] It is used here for illustrative purposes.

[b] NRC = U.S. Nuclear Regulatory Commission.

TABLE 4.28

Annual Average Dose Equivalent in the U.S. Population[a]

Source	Dose (mrem)
Natural	
Radon	228
Internal (^{40}K and ^{226}Ra)	29
Cosmic	33
Terrestrial	21
Medical	
Computed Topography	147
Nuclear Medicine	77
Interventional Fluoroscopy	43
Conventional Radiography & Fluoroscopy	33
Consumer	13
Building Materials	
Commercial Air Travel	
Cigarette Smoking	
Mining and Agricultural	
Combustion of Fossil Fuels	
Highway and Road Construction Materials	
Glass and Ceramics	
Industrial	0.3
Nuclear-power Generation	
DOE Installations	
Decommissioning and Radioactive Waste	
Industrial, Medical, Educational, and Research Activities	
Contact with Nuclear-medicine Patients	
Security Inspection Systems	
Occupational	0.5
Medical	
Aviation	
Commercial Nuclear Power	
Industrial and Commercial	
Education and Research	
Government, DOE, and Military	
Total	624

[a] National Council on Radiation Protection & Measurements (NCRP) report No. 160.[36]

5. ENVIRONMENTAL NONRADIOLOGICAL PROGRAM INFORMATION

5. ENVIRONMENTAL NONRADIOLOGICAL PROGRAM INFORMATION

5.1. Introduction

In addition to monitoring for the release of radioactive materials, Argonne monitors for the release of certain chemicals and monitors changes in environmental conditions. The nonradiological monitoring program involves monitoring of point-source air discharges for certain chemicals and particulates and the collection and analysis of surface water and groundwater samples from numerous locations throughout the site. This chapter discusses the monitoring of releases to the air and surface water. Argonne's groundwater monitoring program is discussed separately in Chapter 6.

5.2. Air Discharges

Argonne operations and research activities utilize a large number of nonradioactive volatile chemicals, fuels, and combustion products that have the potential to adversely impact the environment, if released into the air in sufficient quantities. However, most of these materials are used in very small quantities and the potential environmental impact from their release is negligible. Because of the nature and quantity of potential air emissions, Argonne is not required to monitor the ambient air for pollutants.

The amounts of certain materials discharged to the atmosphere from permitted sources are estimated each year as shown in Table 2.3 in Chapter 2. The vast majority of air releases in 2012 were combustion products discharged from the five on-site natural gas-fueled steam boilers. In past years Boiler No. 5, which is equipped to operate on coal as well as on natural gas, was a major source of sulfur dioxide, nitrous oxides, and other emissions while operating on coal. During 2012 no coal was burned in this boiler, which resulted in a significant reduction in air emissions.

Other significant air discharges include combustion products from several backup power generators that are operated periodically for maintenance reasons and a transportation research facility that studies internal combustion engines. The pollutants discharged are similar to those released from the boiler house. The quantities released are small compared to the quantities released from the boilers, as shown in Table 2.3.

One nonradioactive air pollutant that is monitored is methane gas generated by the decomposition of solid waste in the 800 Area Landfill. The primary purpose of this monitoring is to determine if a potential safety concern exists due to gas migrating into areas or structures around the landfill. Monitoring in 2012 indicated that the gas within the landfill waste mound contained up to 78% methane. Methane was found in a single perimeter well at only 0.1% concentration. While the quantity of gas generated by the landfill is not measured, it is thought to be very low based on gas pressure and observations made during sampling.

Small amounts of research-related volatile chemicals are released into the air when laboratory wastewater is treated in the LWTP. The amount of volatile organic chemicals in the LWTP wastewater is calculated each month based on the analysis of a monthly sample of wastewater flowing into the plant, as discussed in Chapter 2. During 2012, the estimated amount of chemicals released from the LWTP was approximately 53 kg (116 lb), which is lower than in previous years. The individual results from the influent wastewater samples are shown in Table 5.1. The 2012 results are similar to those from recent years. Low concentrations of bromodichloromethane, bromoform, chloroform, and dibromochloromethane were found in nearly all of the samples. These compounds are halogenated organic chemicals that are produced when chlorine is added to the water supply during treatment. The chlorine interacts with naturally occurring organic chemicals in the water and produces low concentrations of a number of chlorinated or brominated chemicals collectively known as Trihalomethanes (THMs). Some of these compounds remain in the wastewater and are detected in the influent samples. The drinking water limit for the sum of all of the THM compounds is 80 μg/L. The sum of the concentrations detected in Argonne's water, provided by the City of Chicago and purchased from the DuPage Water Commission, is well below this limit.

In addition to the THMs, a number of other chemicals from laboratory operations were detected in at least one sample, as shown in Table 5.1. The only chemical consistently detected was acetone which was found in all of the samples. The presence of acetone, ethanol, and other chemicals is likely the result of equipment cleaning. Since 1998, concentrations of acetone and similar chemicals in the wastewater have been consistently low, largely due to educational efforts to minimize use and discharge of chemicals into the laboratory sinks. As discussed in Section 5.3.4 of this chapter, only THMs were detected in the effluent from the wastewater treatment plant, so the small amount of chemicals discharged to the sewer are effectively removed in the wastewater treatment plant prior to discharge.

TABLE 5.1

Laboratory Influent Wastewater, 2012
(concentrations in μg/L)

Compound	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Chlorination By-Products												
Bromodichloromethane	1	<1	<1	1	1	1	2	1	1	1	1	1
Bromoform	<1	<1	<1	4	3	2	3	3	6	2	1	2
Chloroform	1	<1	2	1	1	2	3	1	1	1	1	1
Dibromochloromethane	1	<1	<1	2	2	1	3	1	2	1	1	2
Laboratory Chemicals												
2-Propanol	–[a]	–	–	–	–	–	–	–	–	–	–	19
2-Butanone	–	–	–	–	–	–	–	3	1	–	–	–
Acetaldehyde	102	–	–	–	–	–	–	–	26	–	–	–
Acetone	139	41	44	41	6	66	102	744	12	41	82	3106
Decanes (total)	–	–	–	–	–	–	–	–	48	–	–	–
Ethanol	68	5	–	–	–	–	–	–	41	–	–	–

[a] A dash indicates the compound was not detected in the sample. Detection limits ranged from 1 to 5 μg/L.

5.3. Surface Water

Samples of wastewater discharged into on-site streams and Sawmill Creek are routinely collected. Most of the sampling performed is required by the site's NPDES wastewater discharge permit. Sampling frequency and analyses conducted are determined by permit-mandated monitoring requirements for each outfall. The results of the analyses are compared with the permit limits for each outfall to determine whether they comply with the permit. The results are transmitted monthly to the IEPA in a DMR.

Besides the NPDES permit-required sampling, surface water is sampled at several locations near the site as part of the environmental surveillance program. The overall effect of Argonne site discharges on Sawmill Creek and the Des Plaines River are monitored by sampling downstream of the site and comparing the results with samples collected upstream of the site. The results from radiochemical analysis of these samples are discussed in Chapter 4. This chapter discussed the nonradiological results.

5.3.1. Treated Wastewater Discharges

Sanitary wastewater is generated at Argonne by the cafeteria, sanitary facilities, and custodial operations. A separate laboratory wastewater system collects wastewater generated in laboratories and other research operations. These wastewater streams are treated in on-site wastewater treatment facilities before they are discharged to Sawmill Creek. Section 2.2 contains a description of the wastewater treatment facilities. In addition, in several areas, wastewater which does not require treatment prior to discharge (i.e., steam condensate, non-contact cooling water, and air compressor condensate) is discharged directly into storm drains. The discharge of these wastewater streams is regulated by the NPDES permit.

The main treated wastewater outfalls are the SWTP discharge, Outfall A01, and the treated water from the LWTP, Outfall B01. These outfalls are internal monitoring points; their flows combine before they discharge to Sawmill Creek. The combined discharge is known as Outfall 001, which is also located at the WTP. The combined wastewater flows through an outfall pipe that discharges into Sawmill Creek approximately 1,100 m (3,500 ft) south of the WTP, at the location designated as 7M in Figure 1.1.

The NPDES permit requires monitoring of several direct discharge outfalls. These outfalls also contain stormwater after a rain; however, the permit limits and monitoring requirements apply only to the process wastewater discharges; they are not sampled during periods when stormwater is also flowing, when no flow is visible, or when the outfall is completely frozen.

Four stormwater-only outfalls convey stormwater from potentially contaminated areas in the 800 Area and the 317/319 Area. For these outfalls, stormwater runoff is sampled after a rain event. If no runoff occurs during the sampling period, no samples are collected. Because of the dry conditions throughout 2012, few stormwater samples were collected.

5.3.2. Sample Collection and Analysis

Wastewater samples are collected from Argonne outfalls as specified by the current NPDES permit. Sample collection, preservation, holding times, and analytical methods utilized are consistent with those approved by the EPA. All samples are collected in specially cleaned and labeled sample bottles with appropriate preservatives added. Also, custody seals and chain-of-custody sheets are used as needed. Samples are submitted to the appropriate laboratory for analysis. Testing is completed within the required holding time.

Samples are analyzed by using EPA-approved analytical methods found in 40 CFR Part 136, "Test Procedures for the Analysis of Pollutants under the Clean Water Act"[19], "Test Methods for Evaluating Solid Waste" (EPA-SW-846)[29], and Standard Methods.[20] Analyses are conducted by the Argonne ESQ Analytical Services (ESQ-AS) laboratory as well as by commercial laboratories. Field measurements, including pH, temperature, and dissolved oxygen, are performed by Argonne monitoring program personnel.

5.3.3. Wastewater Treatment Facility Outfall Monitoring

Outfall A01. This outfall consists of treated sanitary wastewater being discharged by the SWTP. The monitoring requirements and the range of individual results from monitoring during 2012 are shown in Table 5.2. This table also lists the permit limits in effect during 2012 and the number of instances when these limits were exceeded.

TABLE 5.2

Outfall A01 Effluent Limits and Monitoring Results, 2012
(concentrations mg/L except where noted)

NPDES Permit Requirements			Monitoring Results	
Constituent	30-Day Average Limit	Daily Maximum Limit	Range	2012 Exceedances
Flow (MGD)[a]	NA[b]	NA	0.141–0.857 (0.201 Average)	NA
pH (pH units)	NA	6.0–9.0	6.2–7.4	0
BOD_5	10.0	20.0	1–14[c]	0
TSS	12.0	24.0	0.8–9	0

[a] MGD = million gallons per day.

[b] NA indicates that there is no limit or value of the type shown.

[c] Even though one or more values exceeded the 30-day average limit, the average of all of the results for each month did not exceed the limit and the individual values were below the daily maximum limit; thus, there were no exceedances.

Two sets of limits are listed; one is a maximum limit for any single sample (daily maximum limit) and the other is for the average of all weekly samples collected during the month (30-day average limit). No limits were exceeded at this outfall during 2012.

Outfall B01. This outfall consists of treated wastewater from the LWTP. Table 5.3 lists monitoring requirements, effluent limits, and a summary of the 2012 monitoring results for this outfall. This outfall is subject to both concentration limits and mass discharge limits. The mass discharge limit represents the maximum weight of material that can be discharged per day. The mass discharge amount that is compared with the limit is calculated by using the constituent concentration and the flow rate measured the day that the sample was collected. There were no exceedances of either concentration or mass limits in 2012.

TABLE 5.3

Outfall B01 Effluent Limits and Monitoring Results, 2012
(concentrations in mg/L except where noted)

NPDES Permit Requirements			Monitoring Results	
Constituent	30-Day Average Limit	Daily Maximum Limit	Range	2012 Exceedances
Flow (MGD)	NA[a]	NA	0.296–0.873 (0.401 Average)	NA
pH (pH units)	NA	6.0–9.0	7.0–8.0	0
BOD5 concentration	10	20	1–10	0
BOD5 mass (lb/day)	41.9	83.7	2.2–35	0
TSS concentration	12	24	0.4–14[b]	0
TSS mass (lb/day)	50.2	100.5	0.8–46	0
Mercury concentration	0.003	0.006	<0.0002[c]	0
Mercury mass (lb/day)	0.0126	0.0251	<0.0003–<0.0010	0
Oil and grease concentration	15	30	<5	0
Oil and grease mass (lb/day)	62.8	125.6	<6.5–<24.5	0
Iron	NA	NA	<0.5	NA
COD	NA	NA	<20–44	NA
Priority pollutants	NA	NA	–[d]	NA

[a] NA indicates that there is no limit or value of the type shown.

[b] Even though one or more values exceeded the 30-day average limit, the average of all of the results for each month did not exceed the limit and the individual values were below the daily maximum limit; thus, there were no exceedances.

[c] A concentration value shown with a "less than" (<) sign indicates that the constituent was not present above the detection limits of the analytical method. The value shown is the method detection limit.

[d] Priority Pollutant results are presented in Table 5.4.

Outfall B01 is also monitored semiannually (June and December) for priority pollutant compounds. Priority pollutants are 124 organic and inorganic constituents that the EPA has determined deserve special attention in monitoring programs as listed in Appendix A to 40 CFR Part 423 (IEPA does not require Argonne to analyze for dioxin or asbestos). The June sample is to be collected at the same time as the sample for aquatic toxicity testing of Outfall 001 is collected. Samples were collected on June 20 and December 5. Table 5.4 gives the results for those constituents that were found above the analytical detection limits. The results for the other VOCs and all of the metals, semivolatile organic compounds (SVOCs), PCBs, pesticides, and cyanide were less than their respective detection limits. Detection limits for metals ranged from 0.0002 to 0.5 mg/L. For organics, the detection limits ranged from 0.05 to 10 µg/L. The samples contained only very low concentrations of several THMs, which result from the chlorination of drinking water. Traces of these chemicals remain after treatment. In general, these results indicate that the treated wastewater is free of most of the toxic chemicals on this list.

Outfall 001. This outfall contains the combined wastewater from both treatment plants. Composite and grab samples of the combined effluent are collected weekly or monthly, as required by the permit. Table 5.5 lists the monitoring requirements, the permit limits, and the range of values recorded during 2012. The number of permit limit exceedances during 2012 is also shown.

Ten permit exceedances occurred at Outfall 001 in 2012. The dissolved oxygen (DO) limits were exceeded eight times (seven weekly average minimum limits and one daily minimum limit) during the summer months due to unusually hot weather, which warms the wastewater, reducing the solubility of oxygen in the water and increasing the oxygen consumption rate of bacteria in the sand filter beds. There were two ammonia exceedances (weekly average and 30-day average limits) during the month of March due to operational problems with the SWTP.

TABLE 5.4

Outfall B01 Effluent Priority Pollutant Monitoring Results, 2012

Compound[a]	June 20	December 5
Bromodichloromethane (µg/L)	0.5	1.0
Bromoform (µg/L)	0.7	1.0
Chloroform (µg/L)	0.6	1.0
Dibromochloromethane (µg/L)	0.6	1.0

[a] All 124 priority pollutants were analyzed. Only those found are shown in this table.

TABLE 5.5

Outfall 001 Monitoring Results and Effluent Limits, 2012
(concentrations in mg/L except where noted)

NPDES Permit Requirements		Monitoring Results	
Constituent	Limits	Range	2012 Exceedances
Flow (MGD)	NA[a]	0.450–1.710 (0.602 Average)	NA
pH (pH units)	6.0–9.0	6.5–8.2	0
Dissolved oxygen	March-July: Weekly Avg. Min. = 6 Daily Min. = 5.5 August-February: 30 Day Avg. Min = 5.5 Weekly Avg. Min = 4 Daily Min. = 3.5	Monthly Avg.: 5.9 – 8.9 Weekly Avg.: 5.3 – 8.1 Daily: 4.8 – 7.7	8
Ammonia nitrogen	March-May: 30 Day avg.=1.6 Weekly Avg. = 4.1 Daily Max.=9.1 June-August: 30 Day avg.=1.6 Weekly Avg. = 4.1 Daily Max.=14.7 September-October: 30 Day avg.=1.6 Weekly Avg. = 4.1 Daily Max.=9.1 November-February: 30 Day avg.=4.8 Daily Max.=10.9	Monthly Avg.: <0.09 – 4.43 Weekly Avg.: <0.05 – 8.13 Daily: <0.05 – 8.13	2
Chloride	Daily Max. = 500	138–395	0
Sulfate	Daily Max. = 500	83–226	0
Copper	30 Day Avg. = 0.0244 Daily Max. = 0.0395	<0.020–0.021	0
Total Nitrogen	NA	7.4–16	NA
Phosphorus	NA	0.59–1.26	NA
Beta radioactivity	NA	1.0–26.8	NA
Low-level mercury	NA	<0.0000016–0.0000290	NA

[a] NA = not applicable.

During the years prior to 2012 Argonne had experienced a number of TDS and chloride permit limit exceedances which were caused by road salt used on the roads and parking areas. The TDS limits were removed from the permit in 2011. Chloride remains as a permit limit; however, the relatively mild 2012 winter weather reduced the amount of road salt used. As a result, there were no exceedances of the chloride limit in 2012.

The permit requires annual biological toxicity testing of Outfall 001. This test was performed using a composite sample collected on June 20 and June 21, 2012. Two types of organisms, water fleas (*Ceriodaphnia dubia*) and fathead minnows (*Pimephales promelas*), were introduced into samples consisting of various ratios of Argonne effluent and dilution water. Survival was measured over two to four days and mortality was reported as a function of effluent concentration. An off-site contract laboratory performed the analyses. This testing concluded that the concentration of wastewater that produces 50% mortality in the test population (i.e., the median lethal concentration [LC_{50}]) was greater than 100%, meaning that even the undiluted effluent is not toxic to these species. Previous toxicity tests conducted since 2001 have all concluded that the combined effluent is not toxic to these species.

5.3.4. Direct Discharge Outfalls

In addition to the three outfalls at the wastewater treatment facilities, nine other outfalls were monitored in 2012. Five of these outfalls currently discharge, or have discharged at some time in the past, process wastewater that does not require treatment prior to release, as well as stormwater. Four of the nine outfalls discharge only stormwater. The sampling requirements and a summary of the results of the 2012 monitoring are contained in Table 5.6.

None of the direct discharge outfalls monitored in 2012 experienced permit exceedances. Two outfalls, Outfall 004 and Outfall 006, require sample collection and analysis only when certain pieces of emergency back-up process equipment are operating. These pieces of equipment discharge once-through cooling water (potable water) into storm drains, necessitating monitoring. Throughout 2012, neither of these pieces of equipment operated. As a result, no samples were collected from these outfalls.

Stormwater at Outfall 021 is analyzed once per year for priority pollutants. Because of ongoing remedial actions in the 317 and 319 Areas, the potential for release of toxic organic chemicals into stormwater runoff exists. The 2012 sample was collected on December 20, 2012. None of the 124 compounds contained on the priority pollutant list was detected to be above the analytical detection limits; however, five VOCs were reported as being present in the sample, but at estimated concentrations less than the quantitation limit of 1 μg/L. The compounds detected were carbon tetrachloride, chloroform, 1,1-dichloroethane, tetrachloroethane, and 1,1,1-trichloroethane. All of these compounds are present in the soil and groundwater in the 317 Area, so their presence in stormwater is not unexpected. The very low concentrations present indicate that very small amounts of these chemicals are released from the soil into stormwater runoff.

TABLE 5.6

Summary of Monitored Direct Discharge NPDES Outfalls, 2012

			Sample Results	
Outfall	Constituent	Permit Limit	Range	2012 Exceedances
D03	Flow (MGD)	NA[a]	0.002–0.012	NA
	pH	6–9	7.5–8.0	0
	Temperature (°C)	<2.8°C rise	11.0–31.4	0
G03	Flow (MGD)	NA	0.002–0.037	NA
	pH	6–9	7.2–8.1	0
	Temperature (°C)	<2.8°C rise	3.6–24.3	0
004	Flow (MGD)	NA	No flow[b]	NA
	TRC (mg/L)	0.05		0
C05	Flow (MGD)	NA	0.003–0.143	NA
	pH	6–9	7.3–8.5	0
006	Flow (MGD)	NA	No flow[b]	NA
	TRC (mg/L)	0.05		0
021[c]	Flow (MGD)	NA	0.010–0.323	NA
	Hydrogen-3 (pCi/L)	Monitor only	<100	NA
	Iron (mg/L)	Monitor only	<0.5	NA
	Priority pollutants	Monitor only	–[d]	NA
A22[c]	Flow (MGD)	NA	0.005	NA
	Hydrogen-3	Monitor only	<100	NA
B22[c]	Flow (MGD)	NA	<0.025–0.029	NA
	Hydrogen-3	Monitor only	<100	NA
023[c]	Flow (MGD)	NA	0.003	NA
	Hydrogen-3	Monitor only	<100	NA

[a] NA = not applicable; the parameter is a monitor-only constituent and the limit exceedance is not applicable.

[b] No process wastewater was present at this outfall; therefore, no samples were collected.

[c] Stormwater-only outfall.

[d] A dash indicates that priority pollutant results are presented in Section 5.3.4.

5.4. Surface Water Surveillance

To supplement the permit-required monitoring, other analyses are voluntarily conducted on samples collected from the combined treatment plant effluent (Outfall 001), Sawmill Creek, and the Des Plaines River upstream and downstream of the site. These samples are analyzed for a number of inorganic constituents and radiological parameters. The results of the radiological analyses are discussed in Chapter 4. The results of the inorganic analyses are presented in this chapter. There are no nonradiological parameters analyzed on the Des Plaines River samples. The inorganic results for Outfall 001 and Sawmill Creek are compared with the IEPA's General Effluent Standards and Stream Quality Standards listed in IAC, Title 35, Subtitle C, Chapter I.[21] While Argonne is not directly required to meet these standards in the effluent or Sawmill Creek, they provide a useful frame of reference against which the effluent and stream quality can be compared.

Combined treatment plant effluent. Composite samples for analysis of inorganic constituents were collected daily from Outfall 001. The results of the analysis are shown in Table 5.7. As shown in this table, the pH was within the acceptable range throughout the year.

One of the weekly samples contained silver above the detection limits. All other metals were below their detection limits. All 52 samples contained low, but detectable, levels of fluoride. None of the parameters exceeded the IEPA's General Effluent Limits.[22]

Sawmill Creek. To determine the impact that Argonne wastewaters have on Sawmill Creek, composite samples of the creek downstream of all Argonne discharge points were collected and analyzed. The results were then compared with IEPA General Use Water Quality Standards found in 35 IAC, Subtitle C, Part 302.[23]

The results obtained for 2012 are shown in Table 5.8. The pH was in the appropriate range throughout the year. Fluoride was present in all of the samples, but well below the standard. All of the metals were below their detection levels. None of the results were higher than the General Use Water Quality Standards.

5.5. Additional Stormwater Monitoring

The Postclosure Care Plan[24] for the 800 Area Landfill requires the quarterly sampling of stormwater discharges from the landfill site. Stormwater flows from the landfill area through two outfalls, 023 and 114. Outfall 023 (old Outfall 113) is also included in the NPDES program. These two outfalls are monitored for TDS, TSS, and pH. No limits are included in the plan. Due to the dry weather during 2012, only one stormwater sample from each outfall was collected in 2012. There was no runoff much of the year. The results for 2012 are shown in Table 5.9. Comparing these values with other NPDES discharges in 2012 suggests that there is no indication of stormwater contamination from landfill operations.

TABLE 5.7

Chemical Constituents in Effluents from the Argonne Wastewater Treatment Plant, 2012

		Concentration (mg/L)		
Constituent	No. of Samples	Average	Maximum	IEPA Limit
Arsenic	52		<0.025[a]	0.25
Barium	52		<0.5	2.0
Beryllium	52		<0.0025	–[b]
Cadmium	52		<0.0025	0.15
Chromium	52		<0.05	1.0
Cobalt	52		<0.25	–
Copper	52		<0.025	0.5
Fluoride	52	0.89	1.27	15.0
Iron	52		<0.09	2.0
Lead	52		<0.075	0.2
Manganese	52		<0.0002	1.0
Mercury	52		<0.05	0.0005
Nickel	52		<0.0025	1.0
Silver	52	<0.0025	0.0035	0.1
Thallium	52		<0.075	–
Vanadium	52		<0.5	–
Zinc	52		<0.025	1.0
pH	52	NA[c]	7.1–7.9[d]	6.0–9.0

[a] If all values were less than the detection limit for a constituent, only the detection limit value is given.

[b] A dash indicates that there is no effluent limit for this constituent.

[c] NA = not applicable; pH values are not averaged since they are log functions.

[d] The lowest and highest pH values are given.

The LTS Program monitors stormwater downstream of the 317 Area and 319 Landfill to determine if any contaminants from the remediation area are being released into surface water. Because of the characteristics of the drainage area, flow is present only immediately after a major storm event. Four stormwater samples were collected during 2012. The results are summarized in Table 5.10. Results showed that 1,1,1-trichloroethane, carbon tetrachloride, and chloroform were present above the analytical detection limits of 1 µg/L. Several other chlorinated organics were reported at levels below 1 µg/L and are therefore considered to be estimated values. All of the compounds detected are also present in the soil and groundwater in these areas. The presence of these compounds in stormwater indicates that a small amount of migration from soil to rainwater runoff is occurring.

TABLE 5.8

Chemical Constituents in Sawmill Creek, Location 7M[a], 2012

Constituent	No. of Samples	Concentration (mg/L) Average	Maximum	IEPA Limit
Arsenic	52		<0.025[b]	0.36[c]
Barium	52		<0.5	5.0[d]
Beryllium	52		<0.0025	–[e]
Cadmium	52		<0.0025	0.024[c]
Chromium	52		<0.05	1.15[c]
Cobalt	52		<0.25	–
Copper	52		<0.025	0.040[c]
Fluoride	52	0.60	1.44	16.3[c]
Iron	52		<0.5	1.0[d]
Lead	52		<0.09	0.20[c]
Manganese	52		<0.075	8.2[c]
Mercury	52		<0.0002	0.0022[c]
Nickel	52		<0.05	0.18[c]
Silver	52		<0.0025	0.005[d]
Thallium	52		<0.002	–
Vanadium	52		<0.075	–
Zinc	52		<0.5	0.26[c]
pH	52	NA[f]	7.0–8.0[g]	6.5–9.0

[a] Location 7M is downstream of the Argonne wastewater outfall.

[b] If all values were less than the detection limit for a constituent, only the detection limit is given.

[c] Value is the acute standard for protection of aquatic organisms calculated from equations given in 35IAC302.208, using a hardness value of 246 mg/L.

[d] Value is the general surface water standard given in 35IAC302.208 g.

[e] A dash indicates that there is no effluent limit for this constituent.

[f] NA = not applicable; pH values are not averaged since they are log functions.

[g] The lowest and highest pH values are given.

TABLE 5.9

Average Monitoring Results for 800 Area Landfill Stormwater, 2012

Outfall Number	Total Dissolved Solids (mg/L)	Total Suspended Solids (mg/L)	pH
023 (113)	80	4	7.54
114	107	2	7.64

TABLE 5.10

Results for 319 Landfill Surface Water, 2012

	Sampling Date			
Analyte	Jan 23	May 04	Aug 27	Dec 20
Organic Compounds (µg/L)				
1,1-Dichloroethane	0.6[a]	0.5	1	0.9
1,1-Dichloroethene	0.3	<1	0.2	0.3
1,1,1-Trichloroethane	4	1	2	2
Acetonitrile	ND[b]	13	ND	ND
Carbon Tetrachloride	0.5	7	0.9	0.6
Chloroform	0.5	4	1	1
cis1,2-Dichloroethene	0.3	<1	0.2	<1
Dichlorodifluoromethane	0.2	<5	<5	<5
Tetrachloroethene	<1	0.3	0.5	<1
Trichloroethene	<1	<1	0.2	<1
Radionuclides (pCi/L)				
Hydrogen-3	<100	<100	<100	<100

[a] Values in this table that are less than 1 µg/L are estimated values since they are less than the detection limit for the VOC analytical method used.

[b] ND indicated this compound was not found in this sample. Detection limits are not determined for this compound

6. GROUNDWATER PROTECTION

6.1. Groundwater Protection at Argonne

Groundwater is present beneath the Argonne site in several different geologic units. The uppermost unit consists of glacial drift; a mixture of clay, silt, sand, and gravel deposited during past glacial retreat periods. Some regions within the drift contain high proportions of sand and gravel that are saturated with groundwater. These regions are classified as perched aquifers. Some of these perched aquifers are interconnected and provide a path for groundwater migration, while others are isolated and have limited potential for movement. Dolomite bedrock underlies the glacial drift throughout the site. The dolomite contains numerous cracks, fissures, and solution cavities that allow groundwater to migrate through the stone. This zone contains the uppermost aquifer used near Argonne as a source of drinking water for low-capacity wells. Several hundred feet below the dolomite is a layer of porous sandstone that contains the most commonly used aquifer in this region. The sandstone is isolated from overlying soil and groundwater by a thick layer of shale. Argonne monitors the quality of groundwater in the glacial drift and in the dolomite. The sandstone aquifer is too deep to be affected by Argonne operations.

Regulatory standards intended to protect groundwater resources are contained in IEPA Groundwater Quality Standards (GQS), 35 IAC, Subtitle F, Part 620.[26] Argonne groundwater is considered Class I (potable resource groundwater) under these regulations. The IEPA's approach to determining remediation objectives for cleaning up contaminated groundwater is contained in the Tiered Approach to Corrective Action Objectives (TACO) which is found in 35 IAC742. The TACO Tier 1 groundwater standards are standards established for Class 1 groundwater. Most of these standards are identical to the Class 1 GQS. In addition, DOE Order 458.1 contains groundwater protection requirements for DOE sites, including the need for a groundwater monitoring program. This chapter documents Argonne's compliance with these requirements. Both radiological analysis results and nonradiological analysis results are discussed in this chapter.

Groundwater quality is maintained through a series of environmental protection efforts, including the proper handling and disposal of chemical waste from Argonne research and support operations, a prohibition on the disposal of chemicals into the laboratory sewer system, the reporting and rapid clean-up of any spills or releases of chemicals, and periodic inspection of outdoor storage areas and rapid resolution of any problems found that could potentially release chemicals into the soil and groundwater. Groundwater beneath several closed waste disposal units is protected by the placement and maintenance of impermeable covers over the waste and routine monitoring of groundwater near the units. In the 317/319 Area, groundwater quality has been impaired by the disposal, during the 1950s, of liquid wastes into a unit known as a French drain. The contaminated soil and groundwater in this area are being cleaned up using several remedial technologies discussed in Section 6.3.

Groundwater quality is monitored by collecting and analyzing samples from a series of groundwater monitoring wells on and adjacent to the Argonne site. A critical element of this program involves permit-required groundwater monitoring at several former waste management units, including the former 800 Area landfill, the 317/319 Area remedial action site, and the former east-northeast (ENE) landfill. Argonne is also voluntarily conducting groundwater monitoring around the perimeter of the 317/319 Area and near the former CP-5 reactor. Samples are also collected from a former on-site water supply well and an artesian well located in the Waterfall Glen Forest Preserve, south of the site.

Monitoring wells are sampled in accordance with EPA protocols described in the *RCRA Ground-Water Monitoring Technical Enforcement Guidance Document*.[27] Prior to collecting any samples, stagnant water is removed from the well. For those wells that recharge rapidly, at least three well volumes are purged by using dedicated submersible pumps or bailers. Shallow wells in the 800 Area and the ENE landfill are sampled using a low-flow purging technique which minimizes disturbance of the groundwater, resulting in samples that are more representative of in situ groundwater. During well purging, field parameters (pH, specific conductivity, oxidation-reduction potential, and temperature) are measured. Sampling is conducted after field parameters have stabilized. For wells in the glacial drift that recharge slowly, the well is emptied completely and allowed to refill. For these wells, field parameters are measured only once. After the well refills, samples are collected using a dedicated Teflon® bailer or pump. Samples for VOCs, SVOCs, PCBs, pesticides, metals, inorganics, and radionuclides are collected in that order. The samples are placed in precleaned bottles, labeled, and preserved in accordance with EPA guidance. Groundwater samples are analyzed for various parameters that are determined by the various permits and objectives of the sampling program. Analyses are conducted using analytical methods approved by the EPA. Radiological analysis methods are based on methods developed by the DOE.

6.2. Groundwater Monitoring at Former Waste Management Areas

During the early years of operation at the present site, certain types of wastes were disposed of in a number of on-site disposal units. These ranged from pits and ditches filled with construction and demolition debris used in the 1950s to a sanitary landfill used for nonhazardous solid waste disposal, which operated until 1992. Several on-site disposal units were used to dispose of chemically hazardous wastes and; therefore, represented a potential threat to the environment. No radioactive waste was knowingly placed in any of these units for disposal; however, radiologically contaminated equipment and debris were placed in some of these units and several areas were contaminated with radioactive materials as they were being used for temporary storage of waste.

Extensive site characterization and remediation of these units was conducted under Argonne's RCRA Corrective Action program administered by the IEPA. The characteristics of the sites were documented in two RCRA Facility Investigation (RFI) reports and a number of similar studies. For those sites where contamination was found, a list of Contaminants of Concern (CoC) and remediation objectives for soil and groundwater were established. Most of the sites were closed by the removal of buried waste and contaminated soil, and no further action was required. However, several waste units were closed with waste or contamination still in place, requiring ongoing remedial actions and monitoring. These units are managed and monitored as part of Argonne's Long-Term Stewardship (LTS) Program. Units that require routine environmental monitoring include the 317/319 Area, the 800 Area Landfill, and the ENE Landfill. Groundwater below these sites is monitored routinely to determine if hazardous materials have migrated from the units. Where contaminants have already been released into the environment, monitoring is carried out to assess the effectiveness of the remedial actions that are underway, and to monitor for changes in the nature and extent of the contamination. The LTS Program and related groundwater monitoring are integrated with the Argonne Environmental Monitoring Program.

6.3. Groundwater in the 317/319 Area

The 317/319 Area contains seven units that have been used for handling or disposal of various types of waste. The 317 Area currently is used for storage of empty radioactive waste containers. It also contains the North Vault, an in-ground radioactive material container storage vault, which is currently empty. Five similar waste storage vaults in this area were cleaned and demolished in place during remedial actions. Low levels of hydrogen-3 are present in the groundwater below this area as a result of past radioactive waste-management practices.

In the 1950s, the 317 Area was used for the land disposal of various nonradioactive liquid chemical wastes in a unit known as a French drain. The drain consisted of a shallow trench filled with gravel into which an unknown quantity of liquid waste was poured. The wastes were primarily petroleum products and chlorinated solvents. Because of these past disposal practices, there is a region of contaminated soil in the northern half of the 317 Area (the 317 French drain). The most highly contaminated sections of the French Drain Area were treated by using a deep soil mixing, steam stripping, and metallic iron treatment technique in 1998. However, areas of untreated soil remain and groundwater below and downgradient of this area contains significant amounts of these chemicals. General features of the 317 and 319 Areas are shown in Figure 6.1.

To prevent off-site migration of contaminated groundwater from the 317 French Drain Area, an underground footing drain pipe associated with the North Vault and four of the five former vaults was sealed by injecting grout into and around the pipes. A groundwater collection system was installed in the southern end of the 317 Area. This system consists of 15 groundwater extraction wells with screens located in the porous zone where contamination is present. This system removes contaminated groundwater before it can move off-site and discharges it into the on-site WTP for treatment and disposal.

The 319 Area contains a closed landfill that was used for disposal of a variety of solid wastes generated on-site prior to 1969. It was not intended for disposal of radioactive waste; however, a small amount of radioactive material, most notably hydrogen-3, was detected in the soil and leachate during site characterization activities that were completed in the 1990s. The 319 Area consists of two distinct segments: the waste mound, where the bulk of the waste was buried, and an adjacent burial trench, which contains a much smaller amount of inert waste. This landfill also contained a French drain that was used for several years after the French drain in the 317 Area was closed. The levels of chemical contamination in the 319 Area are far lower than the levels in the 317 Area; however, hydrogen-3 levels are higher.

In the 319 Area, remedial actions included constructing a subsurface clay barrier wall to prevent migration of leachate, installing a leachate and groundwater collection system to remove

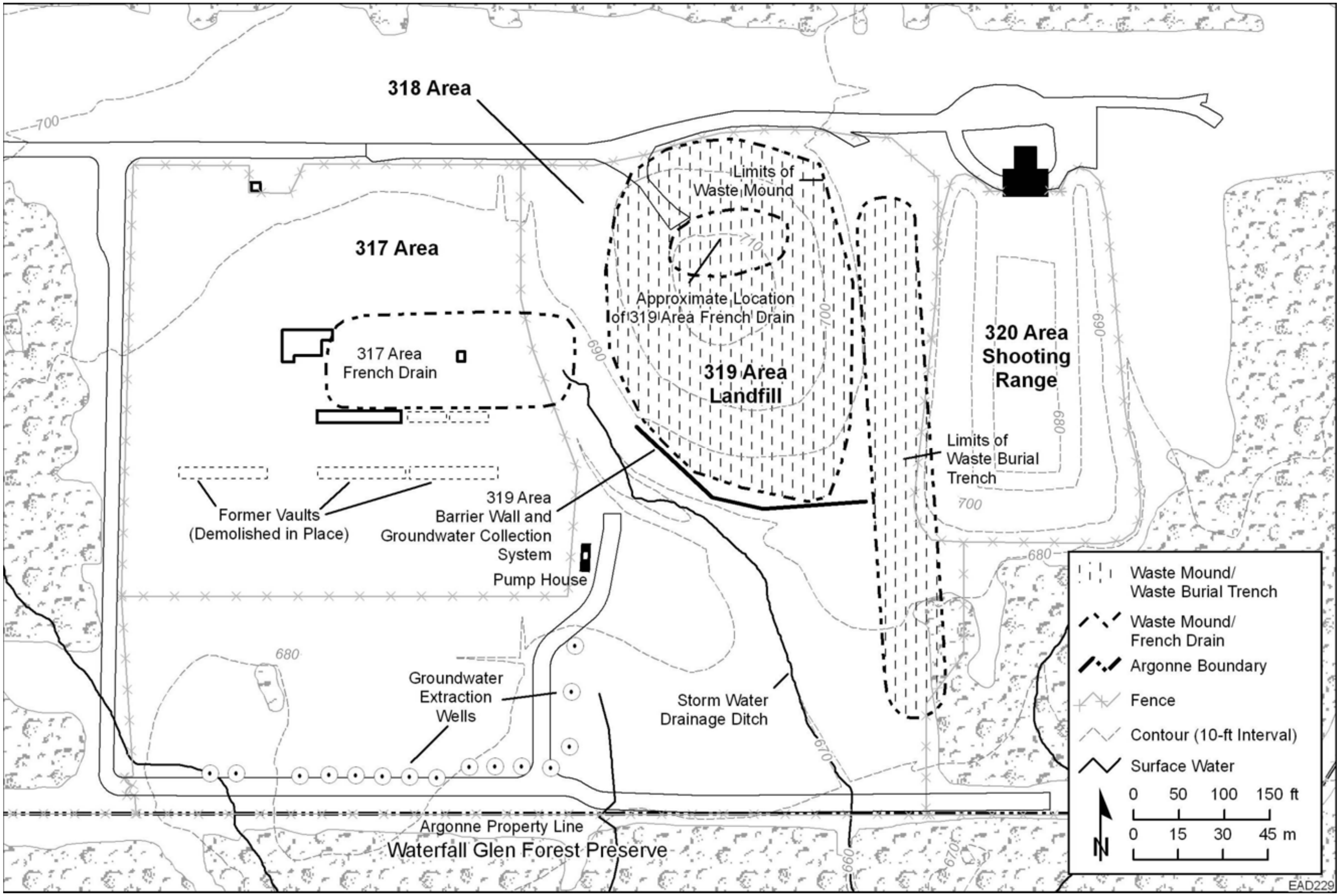


FIGURE 6.1 Locations of Components within the 317/319/ENE Area

accumulated leachate and contaminated groundwater from under the waste mound, and installing a multilayered impermeable cap over the landfill mound and a clay cap over the burial trench.

Groundwater below the 317/319 Area is present in a network of shallow sand and gravel units, up to 6 m (20 ft) thick, within the glacial drift as well as in the upper portion of the dolomite bedrock. The disposal of chemical wastes in the 317 and 319 French drains, as well as the presence of hydrogen-3 in the 319 Area Landfill, have resulted in the generation of a plume of contaminated groundwater extending to the south about 200 m (600 ft). Most of the contamination is present in a porous zone 6 to 10 m (20 to 30 ft) deep in the glacial drift; however, low levels of contamination have been found in the dolomite aquifer. A small amount of contaminated groundwater from the 317/319 Area comes to the surface approximately 360 m (1,200 ft) south of the 319 Landfill in several small groundwater seeps located at the base of a ravine in the Waterfall Glen Forest Preserve. The seeps contain low levels of several VOCs. During the first few years of monitoring, the seeps also contained hydrogen-3 at concentrations below all applicable standards. In recent years, the levels of hydrogen-3 have decreased to less than the detection limits.

A phytoremediation system was installed in 1999 to address the residual contamination in the 317 French Drain Area and groundwater plume south of the 317/319 Area. Phytoremediation is a technology that uses green plants to remove contaminated groundwater by evapotranspiration. The Argonne system consists of a dense planting of willows and other trees in the vicinity of the 317 French drain and a larger planting of hybrid poplar trees downgradient of the 317/319 Area. Approximately 950 poplar and willow trees were planted. Most of the poplar trees were installed in special lined boreholes designed to guide the tree roots toward the contaminated zones.

An extensive groundwater monitoring program is required by the IEPA in the 317/319 Area. In addition to the permit-required monitoring, Argonne also voluntarily conducts groundwater surveillance sampling in the 317/319 Area. This groundwater surveillance network was established during the early years of the site remediation program and it has provided valuable insight into changes in the contaminant levels as remedial actions have progressed in the area and it provides information on the natural background levels of groundwater constituents upgradient of the area.

6.3.1. Permit-Required Groundwater Monitoring at the 317/319 Area

The LTS Program includes the collection of groundwater data from an extensive network of monitoring wells and other sampling points located throughout the 317/319 Area. The current set of wells is shown in Figure 6.2. The purpose of this monitoring is to track the movement of contaminated groundwater, to determine the rate at which contaminant levels are decreasing, and to monitor the performance of the various remedial actions constructed in the 317 and 319 Areas. During 2012, the LTS wells were sampled quarterly or semiannually, as specified in the RCRA Permit, and they were analyzed for VOCs and hydrogen-3. The results of the LTS groundwater monitoring were transmitted to the IEPA on a quarterly basis through the submittal of Quarterly Progress Reports.

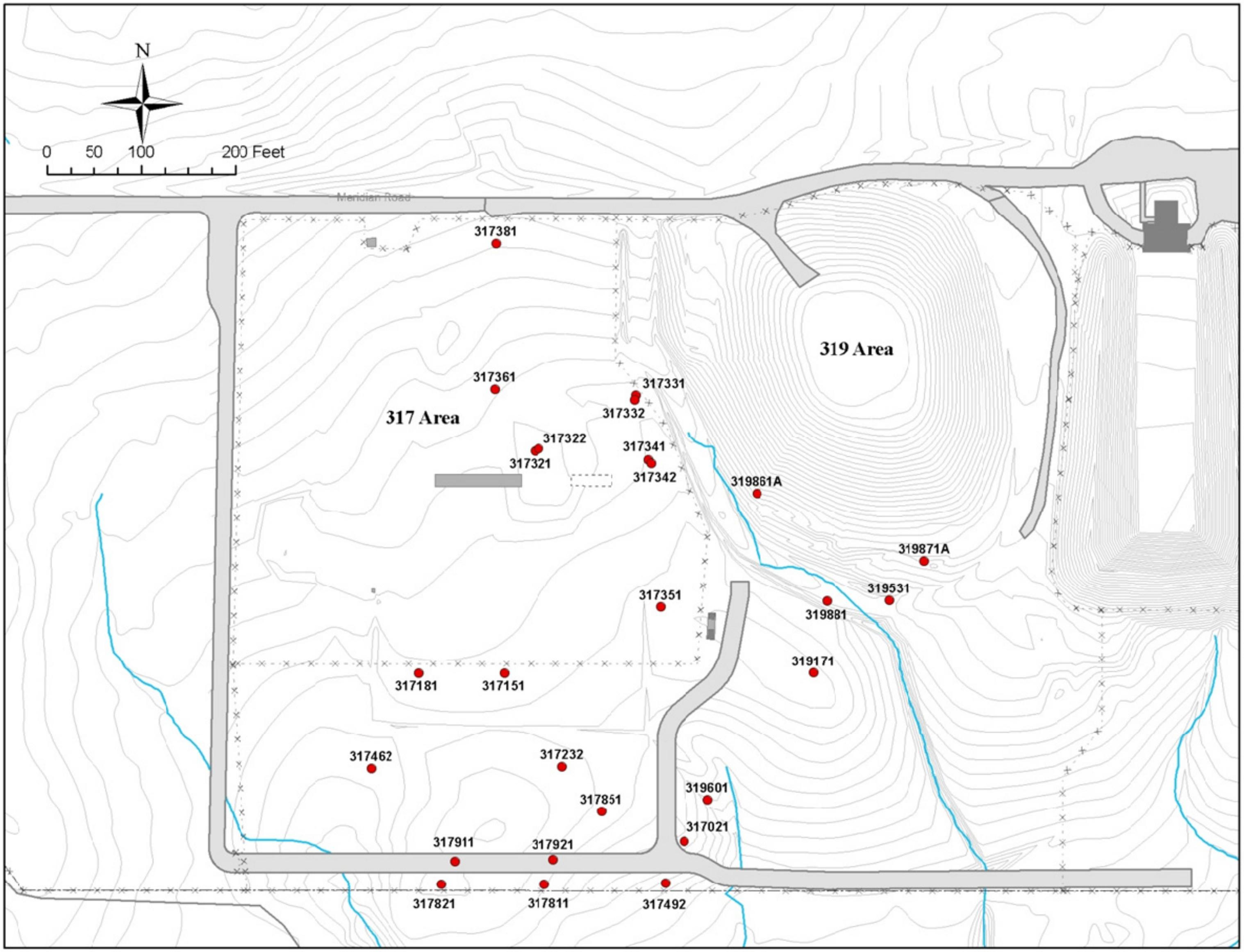


FIGURE 6.2 317/319 Area LTS Monitoring Wells

Because of the number of wells and other sampling points that have been sampled in this area, the volume of analytical data generated is quite large. To simplify the presentation of the data in this report, only a summary of the most significant results is presented. Table 6.1 shows the average VOC concentrations from the 2012 quarterly samples of the four most highly contaminated wells in the French Drain Area. These four wells form two well clusters with one well in each cluster in the uppermost saturated zone (4 to 5 m [13 to 16 ft] deep) and the other in a deeper saturated zone (9 to 10 m [29 to 33 ft] deep). VOCs that were below the quantitation limit in all samples from these four wells are not shown in this table. Values that exceed the applicable IEPA's TACO Tier 1 Groundwater Remediation Objective (GRO) are shown in bold type. A number of constituents that were found do not have a GRO.

The data in Table 6.1 indicate that elevated concentrations of VOCs remain in the French Drain Area. The contaminants present and concentrations in these wells vary tremendously from well to well, and even between the wells in the same cluster, illustrating the heterogeneity of the area. Figure 6.3 shows the long-term trend in annual average total VOC concentrations (the concentrations of all detected VOC added together) in the two most contaminated wells in the 317 French Drain Area since 1999. This chart indicates that the contaminant levels vary from year to year, but no long-term trend is seen. The 2012 results for well 317331 were somewhat higher than those in previous years. The very dry weather conditions during 2012, resulting in lower than normal groundwater elevations, may have contributed to higher than normal VOC concentrations.

Table 6.2 summarizes the 2012 results for detected VOCs in four downgradient wells south of the French drain. Two wells (317151 and 317351) are approximately midway between the French drain and the southern fence line. Wells 317492 and 317811 are immediately north of the fence line. The concentrations found in these wells are much lower than in the French Drain Area; however, several of the constituents are present above Tier 1 GROs.

Figure 6.4 is a chart showing contaminant levels in well 317811 since 1997. This chart shows that contaminant levels have been consistently decreasing since 1999, when the phytoremediation system was installed. The contaminant levels in 2012 were the lowest since monitoring began for this well.

The 2012 monitoring results indicate that high concentrations of VOCs are still present in groundwater in the immediate vicinity of the former 317 French Drain Area. However, downgradient (south) of the French drain, the levels are much lower than in the French Drain Area itself, though some are still in excess of GROs. The groundwater collection systems south of the 319 Area Landfill and the 317 Area are effectively preventing off-site migration of contaminated groundwater and contaminant concentrations at the Argonne fence line and in the 319 Area are steadily decreasing.

Figure 6.5 is a map showing the approximate location of the region of contaminated groundwater within the contaminated aquifer based on the 2012 data. The core of the plume extends from the French Drain Area to the southwest. The edge of the plume extends a small distance off-site into Waterfall Glen Forest Preserve, though the extent of the plume off-site is poorly understood since there are a limited number of monitoring wells in this area. Compared

TABLE 6.1

Annual Average Contaminant Concentrations of French Drain Well Water Constituents, 2012

Parameter	Well No. 317321	317322	317331	317332	TACO Tier 1 Groundwater Remediation Objective[a]
VOC (μg/L)					
1,1-Dichloroethane	<1	**3,165**[b]	**17,005**	**1,491**	700
1,1-Dichloroethene	<1	**30**	**7,624**	**104**	7
1,1,1-Trichloroethane	<1	141	**213,309**	**4,099**	200
1,2-Dichloroethane	<1	**52**	**4,247**	**83**	5
1,4-Dioxane	ND[c]	**937**	**4,705**	**660**	1
4-Methyl-2-Pentanol	ND	1,011	ND	ND	NA[d]
4-Methyl-2-Pentanone	36,326	5,368	4,491	ND	NA
Benzene	**12,033**	**768**	**496**	**18**	5
Carbon Tetrachloride	**351,281**	**4,760**	<1	<1	5
Chloroethane	<5	909	242	12	NA
Chloroform	**62,942**	**3,917**	**875**	**17**	0.2
Chloromethane	<5	34	171	<5	NA
cis-1,2 Dichloroethene	**1,011**	**6,639**	**24,538**	**693**	70
Dichlorodifluoromethane	<5	<5	187	<5	NA
Dichlorofluoromethane	ND	77	77	ND	NA
Ethyl ether	ND	60	ND	ND	NA
Methylene Chloride	<1	**780**	<1	<1	5
Nitrobenzene	**4,234**	ND	ND	ND	3.5
Tetrachloroethene	**1,097**	**343**	<1	<1	5
Toluene	**1,062**	71	49	<1	1,000
trans-1,2 Dichloroethene	<1	85	**1,344**	48	100
Trichloroethene	**39,603**	**1,123**	**56,919**	**531**	5
Trichlorofluoromethane	1,954	60	81	<1	NA
Vinyl Chloride	<2	**1,257**	**164**	**31**	2
Radioactivity (pCi/L)					
Hydrogen-3	425	383	148	<100	20,000

[a] TACO = Tiered Approach to Corrective Action Objectives, Tier 1 standards found in Table E of Appendix B of 35 IAC742.

[b] Bold type indicates that the value exceeds applicable standards.

[c] ND indicates this compound was not detected. Detection limits do not exist.

[d] NA indicates no standard exists for this compound.

with similar plume maps prepared for previous SERs, the plume has decreased in size to the south and southeast of the 317 French drain; however, in 2012, the plume was essentially unchanged compared to the 2011 plume map. The most highly contaminated part of the plume continues to be isolated in the center of the 317 Area; however, since 2008, the leading edge of the southeast part the plume has moved approximately 30 m (100 ft) farther south.

Table 6.3 summarizes the 2012 results for four of the five wells near the 319 Landfill. Two of the wells are located upgradient of the subsurface clay barrier wall and the other two are downgradient of the barrier wall. The VOC concentrations are much lower in the 319 Area than

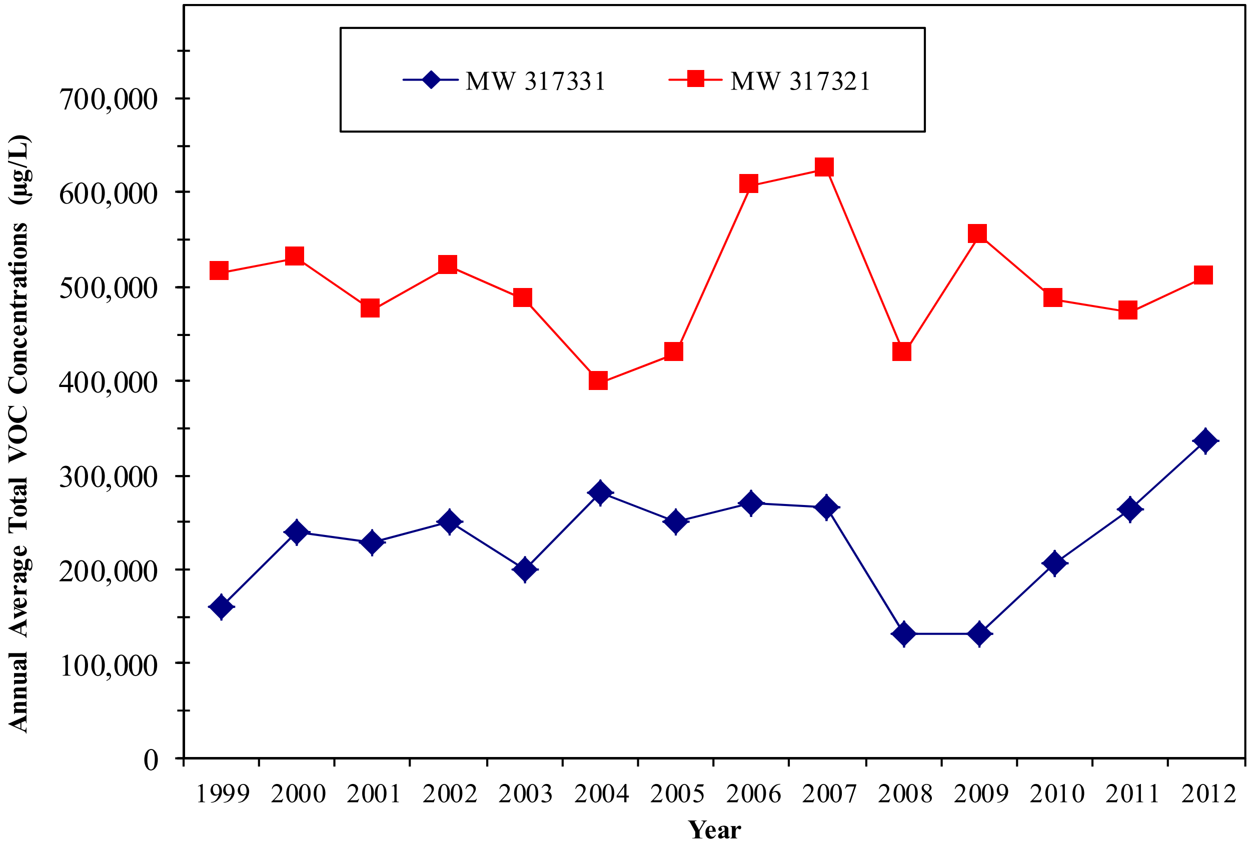


FIGURE 6.3 Annual Average Total VOC Concentrations in 317 Area French Drain Wells

the 317 French Drain Area; however, the hydrogen-3 levels are much higher as a result of past disposal of hydrogen-3 contaminated equipment or soil. Three constituents exceed the GROs.

6.3.2. Monitoring of the Seeps South of the 300 Area

In 1996, during the RFI of the 317/319 Area, three groundwater seeps were discovered in two steeply eroded ravines in the Waterfall Glen Forest Preserve 360 m (1,200 ft) southeast of the 317 and 319 Areas. The ravines carry stormwater drainage from the 317 and 319 Areas and erosion has exposed a thin sandy layer of soil that contains a small amount of groundwater that makes its way to the surface forming three seeps. The water in these seeps was found to contain VOCs and a low level of hydrogen-3, presumably from the 317 and 319 Areas. A shallow hand-dug well of unknown age is located near one of the seeps. Approximately 30 m (100 ft) downstream, the water from the seeps is usually no longer visible because it drains back into the soil in the bed of the ravine or it evaporates. During extended dry-weather conditions, the seeps disappear completely.

Shallow monitoring wells were installed near where the seeps come to the surface. The locations are shown in Figure 6.6. SP04 is located adjacent to the hand-dug well. All three seeps

TABLE 6.2

Annual Average Concentrations of Downgradient French Drain Well Water Constituents, 2012

Parameter	Well No. Wells Midway to Fence 317151	317351	Wells Near Fence Line 317492	317811	TACO Tier 1 Groundwater Remediation Objectives[a]
VOC (μg/L)					
1,1-Dichloroethane	216	<1	0.7	14	700
1,1-Dichloroethene	**14**[b]	<1	<1	0.3	7
1,1,1-Trichloroethane	**617**	<1	2.3	11	200
1,2-Dichloroethane	**15**	<1	<1	<1	5
1,4-Dioxane	ND[c]	ND	ND	**9**	1
Acetonitrile	ND	47	ND	ND	NA[d]
Carbon Tetrachloride	<1	**155**	0.2	0.3	5
Chloroethane	<5	<5	<5	<5	NA
Chloroform	**13**	**140**	<1	**0.4**	0.2
cis1,2-Dichloroethene	13	21	<1	0.6	70
Tetrachloroethene	**79**	**233**	<2	0.7	5
trans1,2-Dichloroethene	<1	<1	<1	<1	100
Trichloroethene	**148**	**6**	0.5	3	5
Radioactivity (pCi/L)					
Hydrogen-3	139	220	<100	<100	20,000

[a] TACO = Tiered Approach to Corrective Action Objectives, Tier 1 standards found in Table E of Appendix B of 35 IAC742.

[b] Bold type indicates that the value exceeds the applicable standards.

[c] ND indicates that this compound was not found in this sample. Detection limits have not been established.

[d] NA indicates that a TACO remediation objective does not exist for this compound.

have been monitored on a regular basis since discovery. Only hydrogen-3 and three VOCs (carbon tetrachloride, chloroform, and tetrachloroethene) have been consistently found. During 2012, the seeps were sampled quarterly for VOCs and hydrogen-3. Table 6.4 summarizes the results. VOCs were noted in all three seeps, but levels of VOCs in SP01 and SP02 were very low, consistently below analytical quantitation limits (results less than 1 μg/L). As usual, Seep SP04 showed the highest levels in all four quarters, and it was the only seep that contained tetrachloroethene (PCE) above detection limits. Figure 6.7 contains a series of charts showing annual average concentrations for these three constituents since 1996. Though the VOCs in all three seeps appear to be declining slowly, the 2012 results were higher than the previous few years. The increase may be related to the extended drought experienced in 2012 which reduced the groundwater table. Seep SP04 was completely dry during the last quarter of 2012.

The hydrogen-3 concentrations in the seeps have decreased from approximately 2,000 pCi/L when they were first discovered. Since 2006 the hydrogen-3 concentrations have

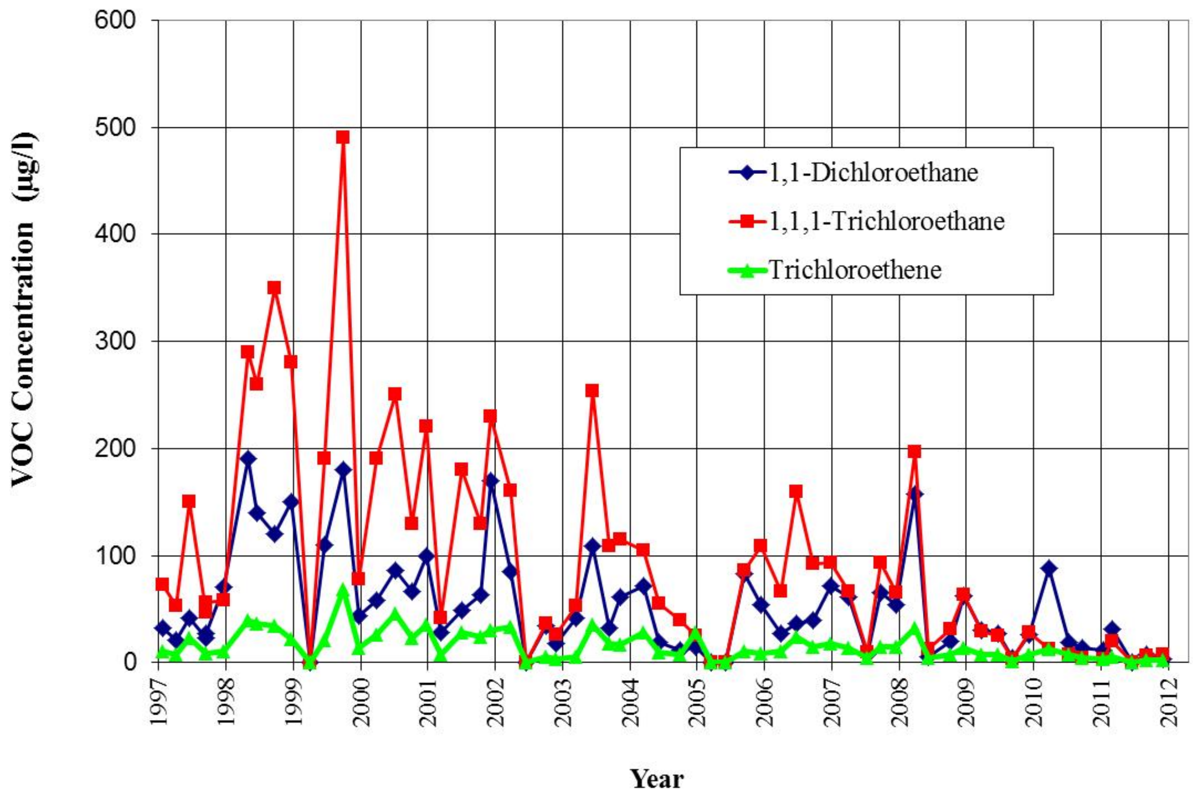


FIGURE 6.4 Contaminant Concentrations in Well 317811 since 1997

been at or below detection levels. None of the 2012 samples had detectable amounts of hydrogen-3. Therefore, it appears that the remedial actions implemented in the 1990s were effective at preventing any further discharge of hydrogen-3. The samples were also analyzed for cesium-137 but none was detected.

6.3.3. Monitoring the Groundwater Management Zone

Because of the nature, extent, and depth of contamination and site constraints, it was not feasible to remove all contaminated soil or groundwater during the active remediation phase. The remedial systems in place are intended to contain residual contamination and slowly reduce contaminant levels until the GROs are attained. The regulatory tool the IEPA utilizes to oversee such a remedial process is a Groundwater Management Zone (GMZ). A GMZ is a three-dimensional region that contains groundwater that exceeds one or more applicable GROs, but is being actively remediated. For a GMZ to be sustained, the groundwater within the GMZ must be managed properly to ensure that cleanup continues until GROs, or some alternative standard approved by the IEPA, are achieved. A GMZ was approved for this area by the IEPA on November 22, 2000. The GMZ encompasses the 317 Area, 319 Area, and the area extending down to the seeps.

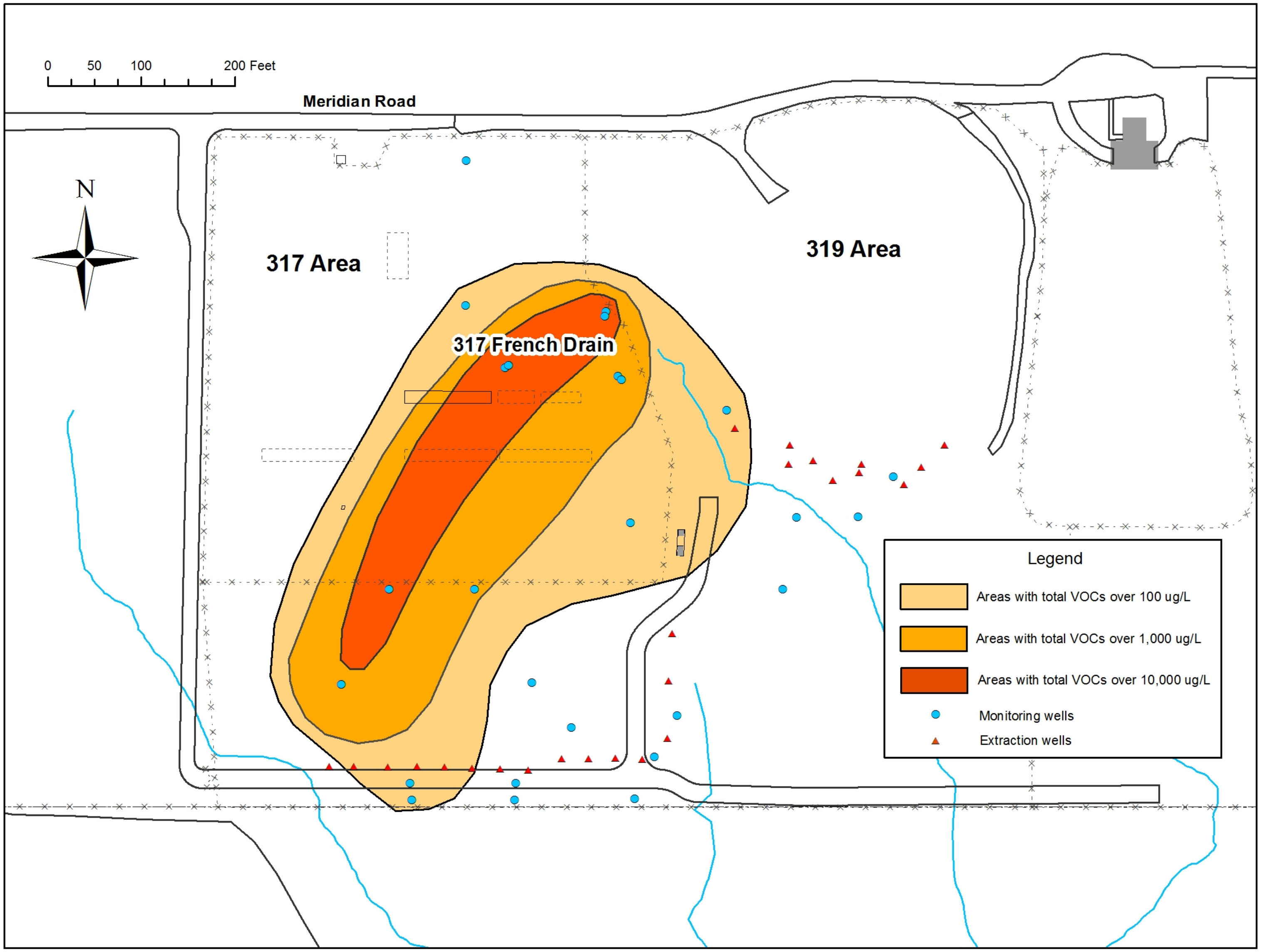


FIGURE 6.5 Region of Contaminated Groundwater in the 317/319 Area during 2012

TABLE 6.3

Annual Average Concentrations of 319 Area Landfill Well Water Constituents, 2012

	Well No.				
	Upgradient of barrier wall		Downgradient of barrier wall		TACO Tier 1 Groundwater Remediation Objectives[a]
Parameter	319861A	319871A	319531	319171	
VOC (μg/L)					
1,1-Dichloroethane	59	0.5	1.8	5.0	700
1,1-Dichloroethene	4.3	<1	<1	1.5	7
1,1,1-Trichloroethane	111	0.3	<1	101	200
1,2-Dichloroethane	**8**[b]	<1	<1	0.3	5
1,4-Dioxane	**33**	<1	**20**	<1	1
Acetonitrile[c]	ND[d]	7	8	8	NA[e]
Benzene	0.3	<1	<1	<1	5
Carbon Tetrachloride	<1	<1	<1	0.3	5
Chloroethane	3.4	<1	0.2	<1	NA
Chloroform	**0.3**	**0.3**	<1	**0.3**	0.2
cis1,2-Dichloroethene	0.4	3.5	27	0.2	70
Dichlorofluoromethane	0.4	0.4	3.3	<1	NA
Ethyl ether	ND	ND	0.9	<1	NA
Tetrachloroethene	<1	0.3	<1	<1	5
trans1,2-Dichloroethene	<1	0.2	2.0	<1	100
Trichloroethene	0.3	2.3	2.5	0.7	5
Vinyl chloride	<2	<2	0.7	<2	2
Radioactivity (pCi/L)					
Hydrogen-3	164	3537	10,309	808	20,000

[a] TACO = Tiered Approach to Corrective Action Objectives, Tier 1 standards found in Table E of Appendix B of 35 IAC742.

[b] Bold type indicates that the value exceeds applicable standards.

[c] ND indicates this compound was not found in this sample. Detection limits have not been established.

[d] This compound was found in several control blank samples and may be a laboratory artifact rather than an actual contaminant.

[e] NA indicates that a TACO Remediation objective does not exist for this compound.

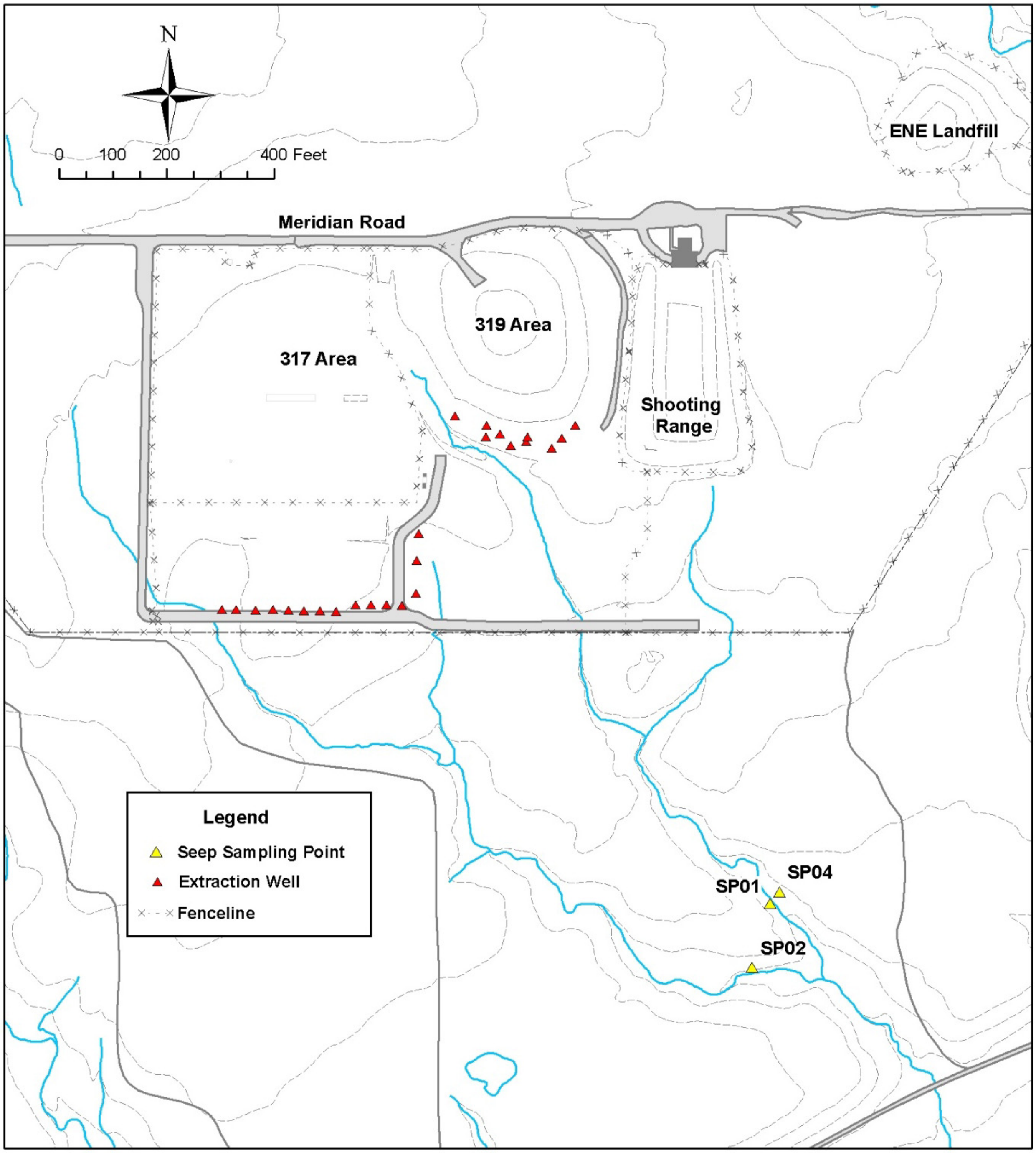


FIGURE 6.6 Seep Locations South of the 317/319 Area

TABLE 6.4

Average Contaminant Concentrations in Seep Water, 2012

	Sampling Location			
Parameter	SP01	SP02	SP04	TACO Tier 1 Standard[a]
Volatile Organic Compounds (µg/L)				
Carbon Tetrachloride	**5.5**[b]	0.9	**174**	5
Chloroform	**1.5**	**0.4**	**20**	0.2
Tetrachloroethene	0.2	<1[d]	**6.3**	5
1,4-Dioxane	0.6	0.5	<1	1
1,1,1-Trichloroethane	0.2	0.2	0.3	200
Trichloroethane	<1	<1	0.2	5
Radionuclides (pCi/L)				
Hydrogen-3	< 100	< 100	< 100	20,000
Cesium-137	<2	<2	<2	NA[c]

[a] TACO = Tiered Approach to Corrective Action Objectives, Tier 1 standards found in Table E of Appendix B of 35 IAC742.

[b] Bold type indicates that the value exceeds applicable standards.

[c] NA indicates no standard exists for this compound.

[d] A concentration value shown with a “less than” (<) sign indicates that the constituent was not present above the detection limits of the analytical method. The value shown is the method detection limit.

The boundaries of the GMZ are delineated by a set of monitoring wells that are located on the outer boundary of the region of contaminated groundwater, both laterally and vertically. These wells are intended to be in clean groundwater, unaffected by past releases. Figure 6.8 shows the locations of these boundary wells.

Samples from the GMZ wells were collected semiannually. The samples were analyzed for the list of Contaminants of Concern for the 317 and 319 Areas and hydrogen-3. The averages of the two semiannual samples collected in 2012 are shown in Table 6.5.

Monitoring results from 2012 indicate that 1,4-dioxane was the only compound in any of the perimeter wells that was present above GROs. 1,4-dioxane was present above the GRO in Well 317951D at 12 and 7µg/L in 2012. It was also found in well 319751 at 2 and 0.6 µg/L, one of which exceeded the limit of 1 µg/L. It was detected in the other deep GMZ well at levels at or below the GRO.

The presence of 1,4-dioxane above the GRO in one of the two deepest GMZ wells indicates that the vertical extent of the contaminated region is not yet defined near this well. In late 2012 a replacement well, drilled deeper than the existing well, was installed to better delineate the bottom of the contaminated region.

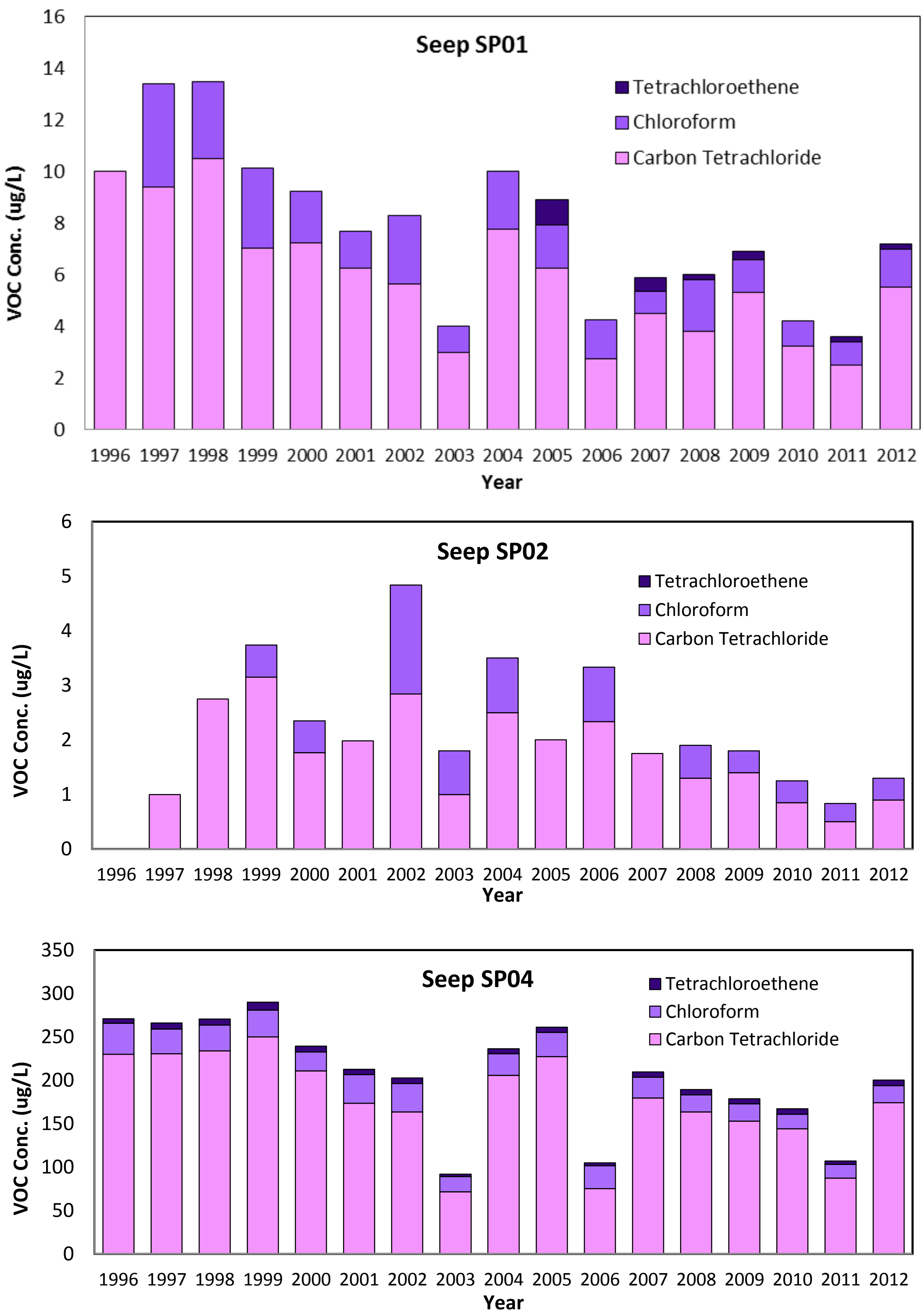


FIGURE 6.7 Groundwater Seeps Annual Average VOC Concentrations since 1996

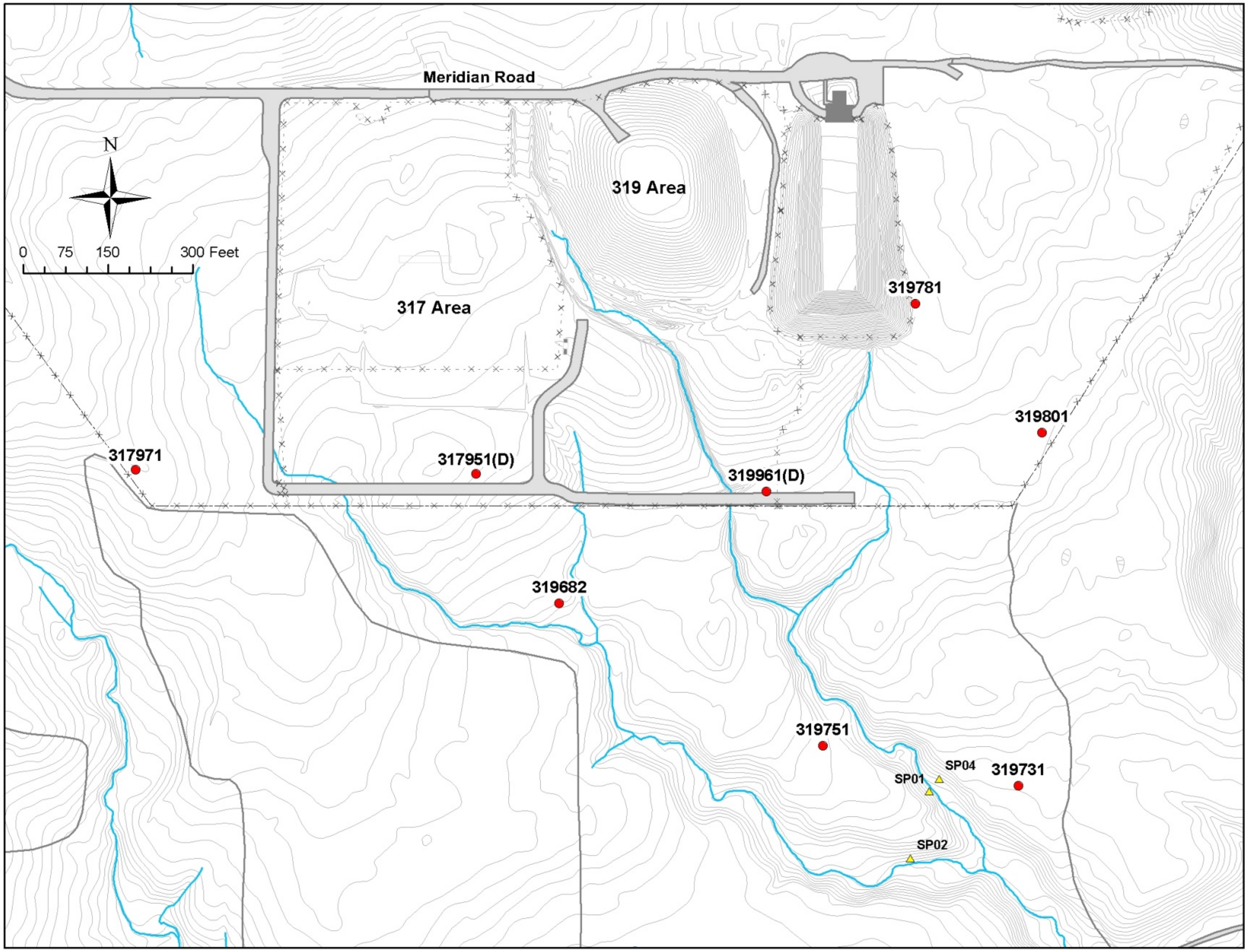


FIGURE 6.8 GMZ Monitoring Wells

TABLE 6.5

Annual Average Results from the GMZ Monitoring Wells, 2012

Parameter	Well No. 317971	319682	319731	319751	TACO Tier 1 GRO
Volatile Organic Compounds (µg/L)					
1,1-Dichloroethane	<1	<1	<1	<1	700
1,1-Dichloroethene	<1	<1	<1	<1	7
1,1,1-Trichloroethane	<1	<1	<1	<1	200
1,1,2-Trichloroethane	<1	<1	<1	<1	0.5
1,2-Dichloroethane	<1	<1	<1	<1	5
1,4-Dioxane	<1	<1	<1	**1.3**[a]	1
Benzene	<1	<1	<1	<1	5
Carbon Tetrachloride	<1	<1	<1	<1	5
Chloroform	<1	<1	<1	<1	0.2
cis 1,2 Dichloroethene	<1	<1	<1	<1	70
Methylene Chloride	<1	<1	<1	<1	5
Nitrobenzene	<3.5	<3.5	<3.5	<3.5	3.5
Tetrachloroethene	<1	<1	<1	<1	5
Trichloroethene	<1	<1	<1	<1	5
Vinyl Chloride	<2	<2	<2	<2	2
Radionuclides (pCi/L)					
Hydrogen-3	<100	<100	<100	<100	20,000

Parameter	Well No. 319781	319801	317951D	319961D	TACO Tier 1 GRO
Volatile Organic Compounds (µg/L)					
1,1-Dichloroethane	<1	<1	0.4	<1	700
1,1-Dichloroethene	<1	<1	<1	<1	7
1,1,1-Trichloroethane	<1	<1	<1	<1	200
1,1,2-Trichloroethane	<1	<1	<1	<1	0.5
1,2-Dichloroethane	<1	<1	<1	<1	5
1,4-Dioxane	<1	<1	**9.5**[a]	0.9	1
Benzene	<1	<1	<1	<1	5
Carbon Tetrachloride	<1	<1	<1	<1	5
Chloroform	<1	<1	<1	<1	0.2
cis 1,2-Dichloroethene	<1	<1	<1	0.5	70
Methylene Chloride	<1	<1	<1	<1	5
Nitrobenzene	<3.5	<3.5	<3.5	<3.5	3.5
Tetrachloroethene	<1	<1	<1	<1	5
Trichloroethene	<1	<1	<1	<1	5
Vinyl Chloride	<2	<2	<2	<2	2
Radionuclides (pCi/L)					
Hydrogen-3	<100	<100	122	627	20,000

[a] Bold type indicates that the value exceeds the GRO.

6.3.4. Supplementary Groundwater Surveillance at the 317/319 Area

In addition to the groundwater monitoring required by the RCRA permit, Argonne has conducted additional groundwater surveillance monitoring in and around the 317 and 319 Areas since the 1980s. This monitoring was started before the remedial actions were begun. The current groundwater surveillance monitoring well network in this area is shown in Figure 6.9. Wells 317101 and 317111 are upgradient of the 317 Area and Well 319011 is upgradient of the 319 Area Landfill. These serve as background reference wells for the downgradient wells.

The surveillance wells are analyzed for a more extensive list of analytes than the LTS wells. With one exception, Well 317021, the wells are not located in the contaminated groundwater plume associated with the 317/319 Area; and thus, the contaminants and concentrations are not representative of the degree of groundwater contamination in other parts of the 317/319 Area.

To determine if groundwater quality at these locations has been impacted, the analytical results were compared to the Class I GQS. The 2012 average results of the filtered chloride and metals analyses as well as the radionuclides cesium-137 and hydrogen-3 are summarized in Table 6.6. The average results for those VOCs that were detected in at least one of the wells are shown in Table 6.7. All of the wells were analyzed once per year for SVOCs, PCBs and pesticides; however, none of the samples had detectable amounts of any of these compounds. To simplify the tables, these results are not shown in the data tables.

Discussion of Results — Well 317101 had chloride levels that exceeded the GQS. This is thought to be related to its proximity to the road where the use of road salt in the winter caused elevated levels of chloride in nearby wells. The five wells with the highest chloride concentrations are all located adjacent to the road. Of the 16 soluble metals analyzed, only nickel in one of four samples collected from well 317951D was detected in any of the wells. This single result was greater than the GQS for nickel. This is likely to be an anomaly since the other three samples from this well were below the detection limit of 0.05 mg/L.

Hydrogen-3 was measured in several of the wells, all far below the GQS of 20,000 pCi/L. The highest concentration was found in 319961D, which is downgradient of the 319 landfill. A small amount of strontium-90 was found in 317941, which is the well closest to a series of demolished radioactive waste storage vaults. No cesium-137 was found in any of the wells.

The only organic chemicals detected were several VOCs shown in Table 6.7. The compounds found were the same as those found in the 317 Area remediation site; however, the concentrations found were much lower than many of the wells associated with that site. The well with the highest concentrations of VOCs is 317941, which is located relatively close to the most contaminated part of the groundwater plume. However, none of the VOCs detected in this well exceeded the GQS. Well 317061R exceeded the GQS for vinyl chloride in two of the four samples collected in 2012. The amount of 1,4-dioxane exceeded the GQS of 1 μg/L in three wells, including one of two dolomite wells. The presence of 1,4-dioxane in several of the surveillance wells is a result of the characteristics of this compound, which is highly soluble in water and moves easily through the soil. It often appears on the outer edge of plumes.

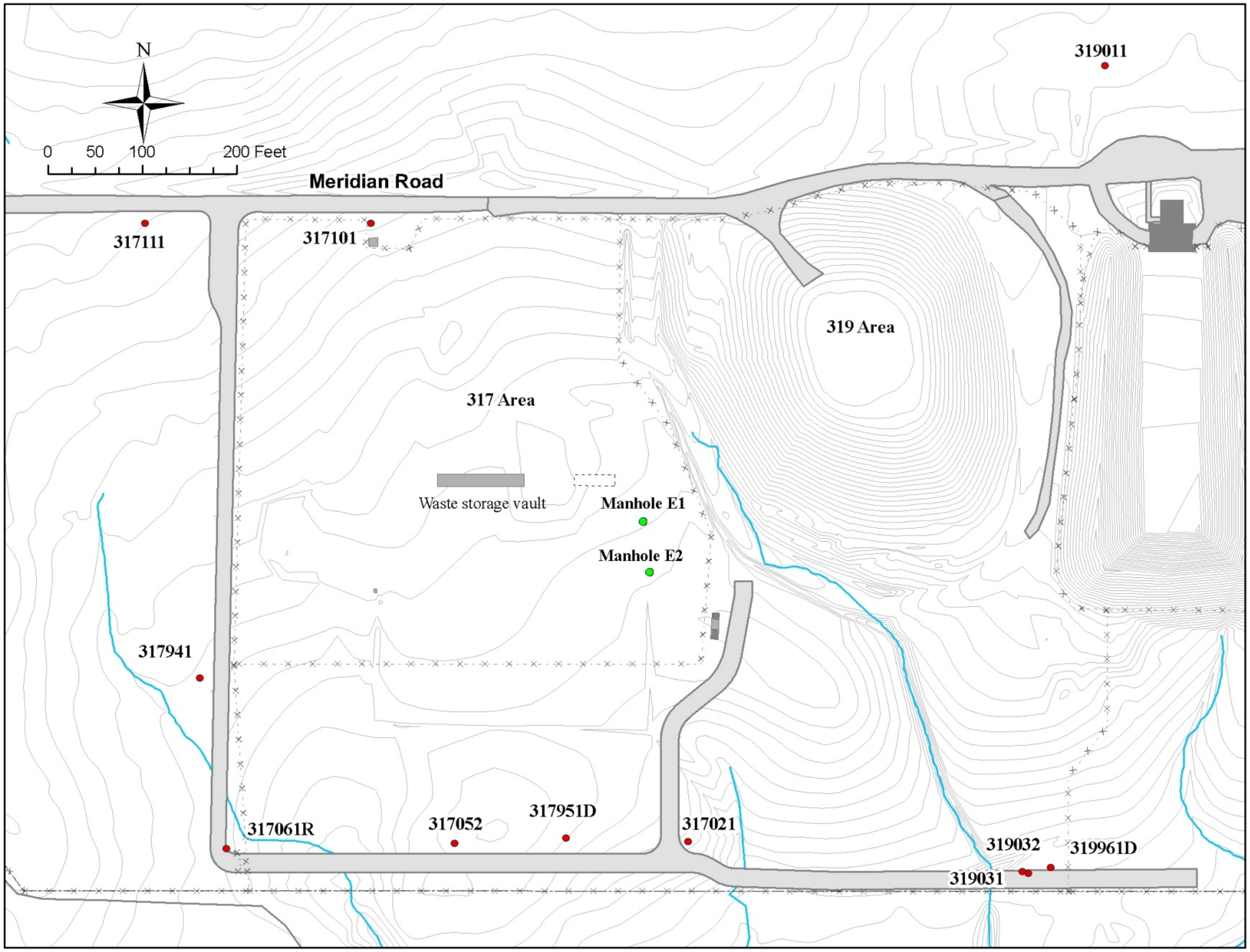


FIGURE 6.9 Groundwater Surveillance Sampling Locations in the 317/319 Area

TABLE 6.6

Annual Average Results from the 317/319 Surveillance Wells, 2012

		Upgradient Background Wells			Downgradient Wells								
Parameter	GRO	317101	317111	319011	317021	319031	319032	317052	317061R	317941	317951D	319961D
Filtered Chloride (mg/L)	200	**279**[a]	98	69	26	14	9	13	122	182	38	41
Filtered Metals (mg/L)												
Arsenic	0.05	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
Barium	2	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Beryllium	0.004	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025
Cadmium	0.005	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025
Chromium	0.1	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Cobalt	1	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25
Copper	0.65	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
Iron	5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Lead	0.0075	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
Manganese	0.15	<0.075	<0.075	<0.075	<0.075	<0.075	<0.075	<0.075	<0.075	<0.075	<0.075	<0.075
Mercury	0.002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Nickel	0.1	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	**0.14**	<0.05
Silver	0.05	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025
Thallium	0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Vanadium	NA	<0.075	<0.075	<0.075	<0.075	<0.075	<0.075	<0.075	<0.075	<0.075	<0.075	<0.075
Zinc	5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Radionuclides (pCi/L)												
Cesium-137	NA	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Hydrogen-3	20,000	<100	<100	<100	<100	174	<100	<100	200	187	152	724
Strontium-90	8	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	1.1	<0.25	<0.25

[a] Bold type indicates that the value exceeds applicable standards.

TABLE 6.7

Annual Average VOC Results from the 317/319 Surveillance Wells, 2012

		Upgradient Background Wells			Downgradient Wells							
Parameter	GQS	317101	317111	319011	317021	319031	319032	317052	317061R	317941	317951D	319961D
VOCs Detected (µg/L)												
1,1-Dichloroethane	700	–[a]	–	–	–	–	–	–	–	5	0.5	–
1,1-Dichloroethene	7	–	–	–	1	–	0.3	–	–	–	–	–
1,2-Dichloroethane	5	–	–	–	–	–	–	–	–	0.2	–	–
1,1,1-Trichloroethane	200	–	–	–	3	2	1	–	–	–	–	0.2
1,4-Dioxane	1	–	–	–	–	**14**[b]	**18**	–	–	–	**6**	–
Acetonitrile	NA	–	–	–	12		16	10	26		2	
Carbon Tetrachloride	5	–	–	–	0.2	–	–	–	–	–	–	0.2
Chloroethane	NA	–	–	–	–	–	–	–	–	0.3	–	–
cis 1,2-Dichloroethene	70	–	–	–	–	–	–	–	–	35	–	0.6
Dichlorofluoromethane		–	–	–	–	–	–	–	–	0.2	–	
Tetrachloroethene		–	–	–	0.2	–	–	–	–	–	–	–
Tetrahydrofuran	NA	–	–	–	–	–	–	–	1	–	–	–
trans 1,2-Dichloroethene	100	–	–	–	–	–	–	–	–	0.9	–	–
Trichloroethene	5	–	–	–	1	2	–	–	–	–	–	0.2
Trichlorofluoromethane	NA	–	–	–	–	0.5	–	–	–	–	–	–
Vinyl Chloride	2	–	–	–	–	–	–	–	**2.1**	1.8	–	–

[a] A dash indicates this compound was not detected in any of the samples from this well during 2012.

[b] Bold font indicates this average result exceeded the GQS for this compound.

In general, the number of compounds detected and concentrations were comparable to or lower than the previous years' results. Figure 6.10 shows the 1,1,1-trichloroethane (TCA) and 1,1-dichloroethane (DCA) concentrations in Well 317021 since 1988, a period that spans all of the remediation activities completed in this area. The levels were low and relatively consistent until 1991, at which time the concentrations increased. During 1995 a rapid decrease in concentrations began. This period represents the time when active remediation of the 317/319 Area was underway. These remedial actions, completed in 1999, may be responsible for the rapid decrease in VOC concentrations in this well. Since 1999, only very low residual amounts of VOCs have been present in this well.

6.3.5. 317 Area Manhole Sampling

In addition to the wells in this area, two manholes associated with the waste storage vault footing drain sewer system are monitored monthly. Figure 6.9 shows the locations of these two manholes. This system conveys water from an interior drain in the North Vault and footing drains around several of the now-demolished vaults (the footing drains were left in place after the vaults were demolished) through Manhole E1 and on to Manhole E2. A pump located in

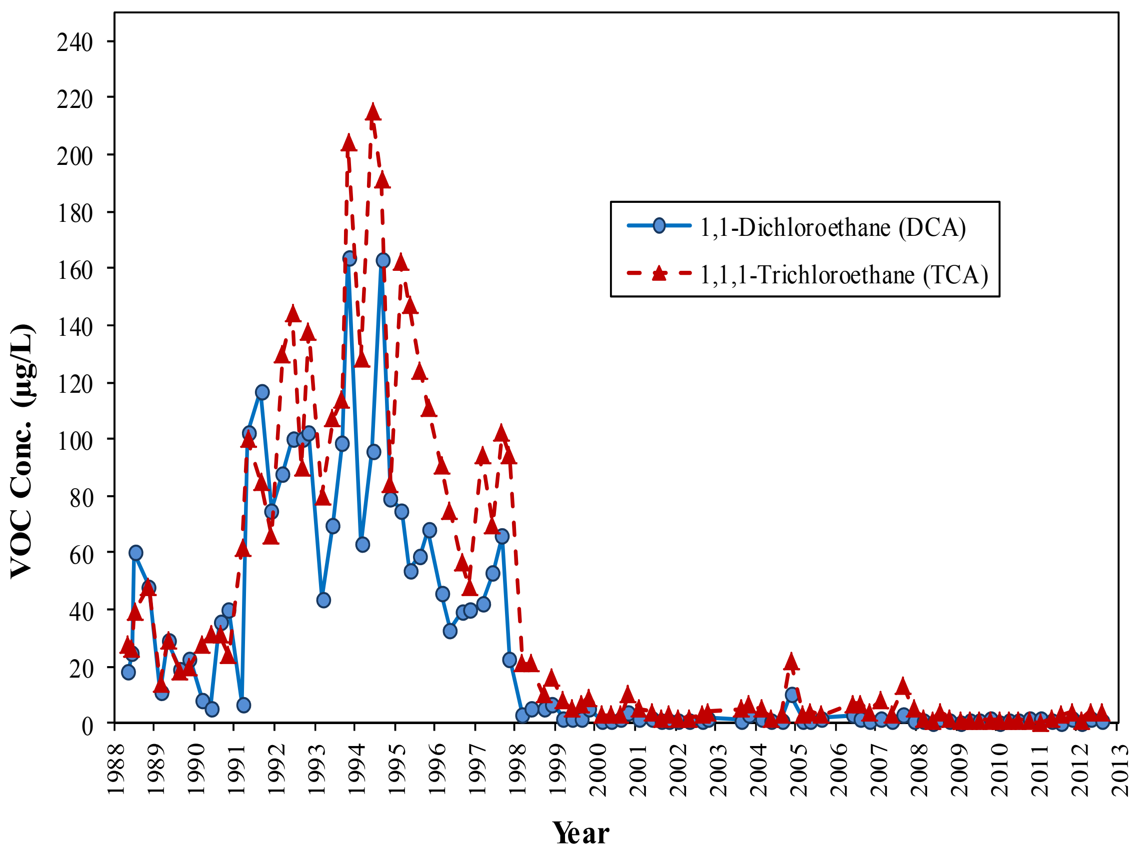


FIGURE 6.10 Concentrations of DCA and TCA in Well 317021

Manhole E2 pumps the water to the on-site LWTP. It is treated and discharged into Sawmill Creek. Since 1997, water collected by the 317 and 319 leachate and groundwater collection systems has also been discharged to Manhole E2 where it is pumped to the treatment plant. Thus, the water in these manholes—particularly Manhole E2—is a mixture of groundwater from vaults in the 317 Area, leachate and groundwater from the 319 Area landfill, and groundwater from the 317 Area groundwater collection system. Monitoring contaminant concentrations in these manholes provides additional information about the progress of remedial actions in the 317 French Drain Area as well as contaminants discharged to the LWTP.

Manholes E1 and E2 were sampled monthly and analyzed for VOCs and hydrogen-3. The results are summarized in Table 6.8. Several of the VOC concentrations in Manhole E1 were much higher than in Manhole E2 due to the dilution that occurs in Manhole E2 from the relatively clean water discharged from the 319 and 317 Area groundwater extraction systems.

Hydrogen-3 was detected in all of the samples; however, all of the results are well below the GQS of 20,000 pCi/L. The highest concentration of hydrogen-3 was 1135 pCi/L in Manhole E1, collected in October of 2012. Cesium-137 was not found in any of the samples. These results are similar to past monitoring results of these manholes, indicating that shallow groundwater surrounding the vaults remains contaminated.

6.4. ENE Landfill Groundwater Monitoring

The ENE Landfill was used in the early years of the site for the disposal of demolition debris, discarded equipment, and other items. In 2001 the waste material was consolidated and a clay cap was constructed over the waste mound. In April 2003, the IEPA issued a RCRA corrective action determination covering postclosure care and groundwater monitoring for the ENE Landfill.

Seven monitoring wells are currently used to collect groundwater samples from near the landfill. Figure 6.11 shows the well locations. The purpose of groundwater monitoring at the ENE Landfill is to verify that contaminants found in the landfill contents, including metals and the PCB Aroclor 1254, which were all above their respective Tier 1 soil remediation objectives, as well as hydrogen-3 and other radionuclides, are not migrating to shallow groundwater. As required by the IEPA, monitoring at the ENE Landfill will be conducted throughout the 15-year postclosure care period, which started in December 2002.

Parameters analyzed twice in 2012 included total PCBs and five soluble (filtered) metals (arsenic, chromium, lead, manganese, and nickel). The same metals are analyzed once per year in unfiltered samples. Some of the wells are equipped with low flow samplers to reduce the impact of suspended sediment in the samples and to produce a more representative groundwater sample. Samples are collected using these samplers whenever possible; however, frequently, groundwater levels are too low or site conditions are too poor to allow this type of sampler to be used. In such a situation, the pump is removed from the well and the sample is collected by

TABLE 6.8

Annual Average VOC Results from the 317/319 Manholes, 2012

	Manhole E1	Manhole E2
VOCs (µg/L)		
1,1-Dichloroethane	16	50
1,1-Dichloroethene	0.3	0.4
1,1,1-Trichloroethane	5	10
1,1,2-Trichloroethane	0.3	<1
1,1,2,2 Tetrachloroethane	0.3	<1
1,2-Dichloroethane	0.9	3
1,4-Dioxane	25	16
Acetonitrile	ND	24
Benzene	0.5	<1
Carbon Tetrachloride	258	44
Chloroethane	0.6	0.7
Chloroform	288	41
cis 1,2-Dichloroethene	35	7
Dichlorofluoromethane	0.8	0.4
Ethyl Ether	0.7	0.3
Naphthalene	0.2	<1
Tetrachloroethene	16	10
trans 1,2-Dichloroethene	1.3	0.5
Trichloroethene	91	15
Trichlorofluoromethane	0.5	0.2
Vinyl Chloride	1.8	0.5
Radionuclides (pCi/L)		
Cesium-137	<2	<2
Hydrogen-3	438	215

hand with a bailer. In these instances, the amount of silt in the sample is much higher, which results in elevated levels of total metals.

The 2012 results from this program are summarized in Table 6.9. In this table the two semiannual filtered metals results are averaged. As shown in this table, several of results exceed the GQSs for arsenic, lead, manganese, and nickel in at least one of the seven wells sampled. The highest unfiltered metals levels were found in the two upgradient wells, indicating that the metals are of natural origin and are not related to the landfill. Except for one instance, the filtered samples from these wells did not contain any detectable metals, indicating the elevated concentrations in the unfiltered sample were primarily the result of suspended sediment in the sample. Only one of the 3 exceedances in 2012 was from a filtered sample, and this exceedance was for manganese, which is a relatively soluble and abundant naturally-occurring metal. Neither PCBs nor hydrogen-3 were detected in any of the wells.

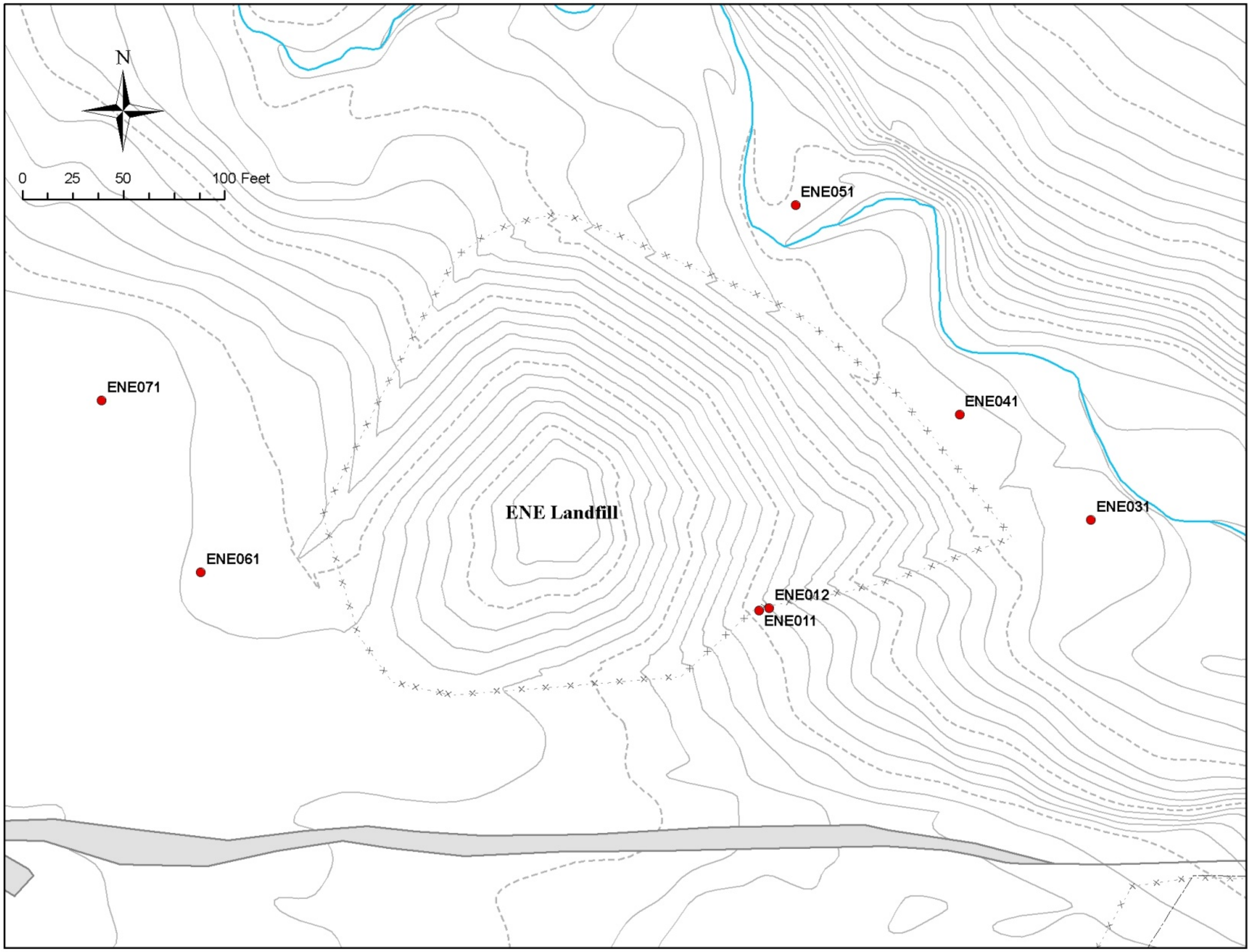


FIGURE 6.11 ENE Area Groundwater Monitoring Wells

TABLE 6.9

Annual Average Concentrations of ENE Landfill Groundwater Constituents, 2012

	Well No.							
Parameter[a]	ENE-011	ENE-012	ENE-031	ENE-041	ENE-051	ENE-061[b]	ENE-071[b]	Standard
Unfiltered Metals (mg/L)								
Arsenic	<0.025	<0.025	<0.025	0.029	<0.025	**0.14**[c]	<0.025	0.05
Chromium	<0.05	0.07	<0.05	<0.05	<0.05	0.1	<0.05	0.1
Lead	<0.004	0.02	<0.004	<0.004	<0.004	**0.093**	**0.020**	0.0075
Manganese	0.098	**1.04**	**0.19**	**0.94**	<0.075	**4.06**	**0.64**	0.15
Nickel	<0.05	<0.05	<0.05	<0.05	<0.05	**0.17**	<0.05	0.1
Filtered Metals (mg/L)								
Arsenic	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	0.05
Chromium	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.1
Lead	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	0.0075
Manganese	<0.075	<0.075	**0.34**	<0.075	<0.075	<0.075	<0.075	0.15
Nickel	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.1
PCB–total (µg/L)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	1
Hydrogen-3 (pCi/L)	<100	<100	<100	<100	<100	<100	<100	20,000

[a] Concentrations in mg/L except where noted otherwise.

[b] Wells ENE-061 and ENE-071 are upgradient, background wells.

[c] Bold type indicates that the value exceeds the GRO.

6.5. Sanitary Landfill Monitoring

The former 800 Area sanitary landfill is located on the western edge of the site (see Figure 1.1). The 8.8-ha (21.8-acre) landfill received miscellaneous solid waste from 1966 until September 1992 and was operated under IEPA Permit No. 1981-29-OP, which was issued in 1981. The landfill received general refuse, construction debris, boiler house ash, and other nonradioactive solid waste. The landfill was also used for the disposal of approximately 109,000 L (29,000 gal) of liquid waste consisting of used oil or used machining coolant (an oil-water emulsion), though small quantities of chemical wastes that would be considered hazardous waste by current regulations were also placed in the landfill.

The landfill was closed in 1992 in accordance with the closure plan established under the operating permit. Closure included the installation of a 0.6-m (2-ft) thick compacted clay cap over the waste mound. A RFI was conducted in 1997 under the RCRA Corrective Action program to determine if any hazardous materials had migrated from the landfill. Measurable amounts of several hazardous materials were identified in leachate in the waste mound. The most common contaminants in the landfill were PCBs and pesticides (Aroclor 1260, DDE, and DDT), several VOCs (toluene, acetone, and methylene chloride), and SVOCs (several phthalates), some of which may have been laboratory artifacts and not actually present in the waste. None of these compounds was found in groundwater near the landfill during the RFI. The study determined that no further remedial actions, beyond post-closure care and groundwater monitoring, were required. A No Further Action (NFA) determination was received from the IEPA in 2003. This letter specified that postclosure groundwater monitoring activities would be carried out for the 15-year postclosure care period, which began in 1999. Post closure care of the landfill is a component of the LTS program. This section discusses the groundwater monitoring results for 2012.

The current groundwater monitoring well network is shown in Figure 6.12. The network consists of two types of wells. Fifteen shallow wells are screened in glacial till between 4 and 14 m (13 and 46 ft) deep. These wells have well screens situated in porous sandy zones within the glacial till. They provide samples of the uppermost layers of groundwater under and adjacent to the landfill. Six deep wells are screened in the top of the dolomite limestone bedrock underlying the glacial till. These six deep wells are situated near five of the shallow wells, forming five well clusters. Two wells are considered background wells (Wells 800271 and 800273D) and they are located approximately 670 m (2,200 ft) to the northeast of the landfill mound. These wells are out of the influence of the landfill and provide information on the background level of groundwater constituents. All monitoring wells are constructed of 0.05-m (2-in.) diameter stainless-steel casings and screens installed in boreholes sealed with bentonite grout, a concrete cap, and a locking steel protective cover.

Since 2009, all shallow wells have utilized low-flow pumps for purging and sample collection. These pumps improve the quality of the samples recovered from these wells since sampling with a bailer disturbs sediment in the well, resulting in elevated values of some metals. Samples from the deeper dolomite wells are collected by using an electronic submersible pump. These wells are screened in fractured rock that does not produce as much sediment as the glacial drift does. Thus, low-flow pumps are not necessary in these wells.

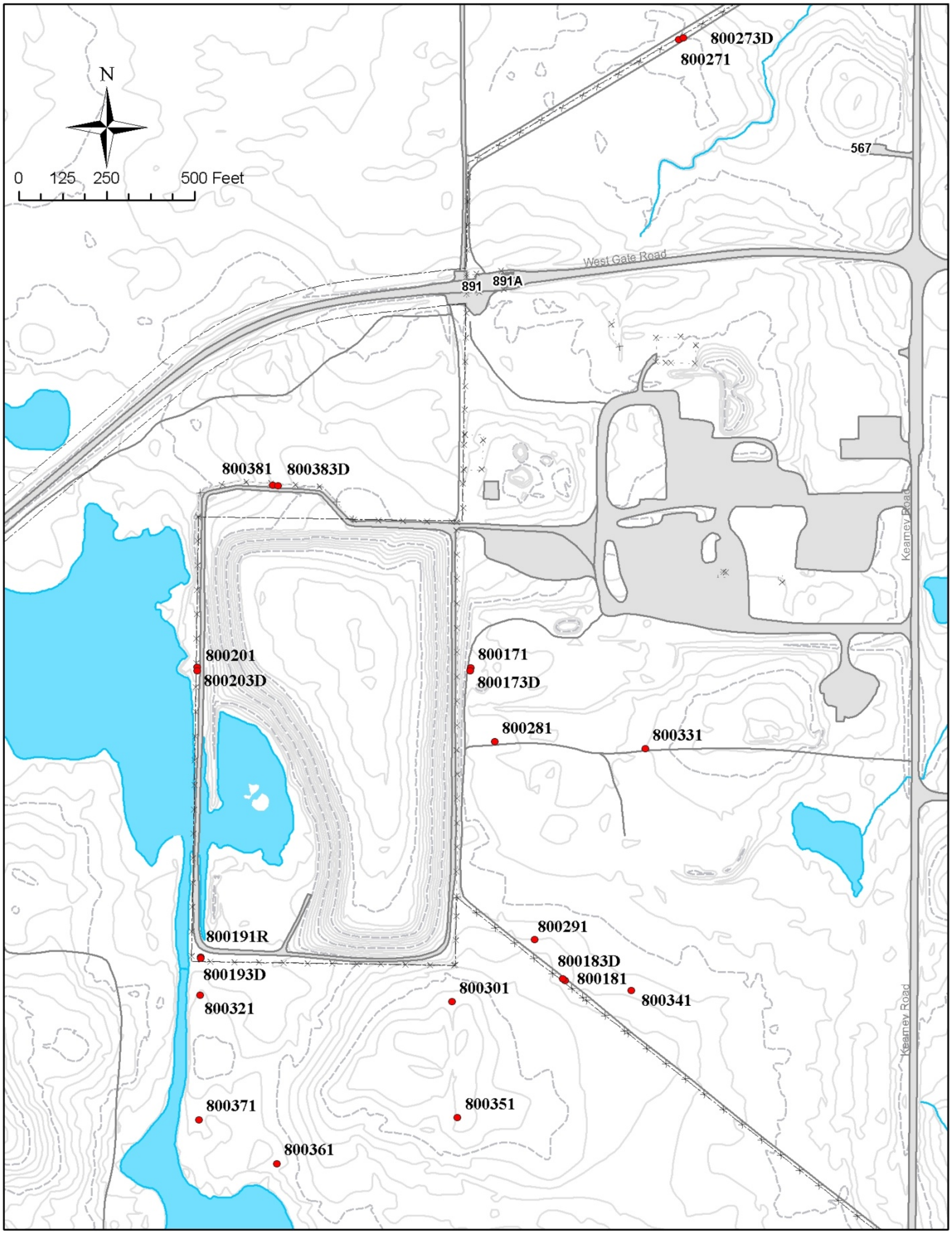


FIGURE 6.12 800 Area Landfill Monitoring Wells

Each well is sampled quarterly for permit-required parameters. During the first, third, and fourth quarters, only the List 1 (field parameters of groundwater depth, pH, specific conductivity, and temperature) and List 2 properties and constituents (filtered metals, sulfate, chloride, TDS, cyanide, phenols, total organic carbon [TOC], and total organic halogens [TOX]) are measured. During the second quarter, additional samples are collected and analyzed for List 3 and 3A parameters (unfiltered metals and certain VOCs, SVOCs, PCBs, pesticides, and herbicides). In addition to the required annual analyses, VOCs and hydrogen-3 are monitored voluntarily by Argonne during all quarters to provide better documentation of conditions under the landfill.

6.5.1. Basis for Evaluation of Analytical Results

In 2005, the IEPA approved a set of background values for groundwater constituents monitored at the landfill. The background values were developed from five years of monitoring results from the two upgradient monitoring wells; one in the shallow glacial drift and one in the dolomite bedrock. The monitoring results are evaluated by comparing the results with either the IEPA-approved background values or the GQS for each constituent, where such limits exist. For routine indicator parameters (Lists 1 and 2), the permit requires the comparison of the individual results with background values. For unfiltered metals and organic constituents, the results are compared with the GQSs for Class I Potable Resource Groundwater (35 IAC Part 620.410), where such standards exist. Where GQS values do not exist, the results are compared with two times the practical quantitation limit (PQL) for that compound, which are listed in the permit. Table 6.10 lists the applicable permit limits for the 800 Area landfill. Footnotes to this table explain the source of the individual groundwater quality limits. To simplify the table, the limits for the long list of organics (two times PQL) are not shown. In the data tables that follow, values that exceed applicable limits are shown in bold print.

6.5.2. Results of Analyses

Field parameters and the results of chemical and radiological analysis for the shallow wells are summarized in Table 6.11. This table lists the average of the quarterly results which were above detection limits. It also lists the individual results for those parameters that were analyzed only once during 2012. Only results for constituents that were above detection limits in one or more samples during 2012 are shown. Ten of the metals analyzed and cyanide were not detected above their respective detection limits in any of the samples and these results are not shown. None of the VOCs, SVOCs, PCBs, and pesticides were detected. To simplify the data tables, results for these constituents are not shown.

6.5.3. Discussion of Results — Shallow Wells

The monitoring results for the shallow wells in the 800 Area landfill during 2012 were very similar to previous year's results. Many of the downgradient wells exhibited levels of

TABLE 6.10

Permit Limits for 800 Area Groundwater

Parameter	Unit	Permit Limit – Shallow Wells	Source[a]	Permit Limit – Deep Wells	Source[a]
Field Parameters					
Conductivity	μS/cm	703	4	1,306	1
pH	pH	6.57–7.88	1	6.48–7.74	1
Filtered Samples					
Ammonia nitrogen	mg/L	0.90	4	1.0	4
Chloride	mg/L	20	4	140	1
Sulfate	mg/L	58	1	150	1
TDS	mg/L	428	1	880	1
Arsenic	mg/L	0.010	2	0.0048	4
Cadmium	mg/L	0.001	2	0.001	2
Iron	mg/L	0.099	4	1.60	1
Lead	mg/L	0.01	2	0.01	2
Manganese	mg/L	0.097	4	0.021	4
Mercury	mg/L	0.002	2	0.002	2
Unfiltered Samples					
Chloride	mg/L	200	3	200	3
Cyanide (total)	mg/L	0.011	4	0.04	2
Fluoride	mg/L	4.0	3	4.0	3
Nitrate	mg/L	10.0	3	10.0	3
Phenols	mg/L	0.033	4	0.033	4
Sulfate	mg/L	400	3	400	3
TOC	mg/L	2.71	5	5.3	4
TOX	mg/L	0.086	4	0.041	4
Arsenic	mg/L	0.05	3	0.05	3
Barium	mg/L	2.0	3	2.00	3
Boron	mg/L	2.0	3	2.00	3
Cadmium	mg/L	0.005	3	0.005	3
Chromium	mg/L	0.10	3	0.10	3
Cobalt	mg/L	1.0	3	1.00	3
Copper	mg/L	0.65	3	0.65	3
Iron	mg/L	5.0	3	5.00	3
Lead	mg/L	0.008	3	0.008	3
Manganese	mg/L	0.15	3	0.15	3
Mercury	mg/L	0.002	3	0.002	3
Nickel	mg/L	0.10	3	0.10	3
Selenium	mg/L	0.05	3	0.05	3
Silver	mg/L	0.05	3	0.05	3
Zinc	mg/L	5.0	3	5.0	3

[a] The various permit limits were generated in the following manner:

1 = Calculated from 95% upper confidence interval of the data set. Calculation used one-half the detection limits for values less than the detection limits.

2 = Background values equal the PQL. All measured values in background wells were below PQLs.

3 = IEPA's Class 1 Groundwater Quality Standard.

4 = Background value based on nonparametric statistical methods for data sets with more than 15%, but less than 100% of measured values below detection limits.

5 = Calculated from 95% upper confidence interval for data set that was first transformed by calculating the natural log of the measured values.

TABLE 6.11

Annual Average Concentrations of 800 Area Landfill Shallow Groundwater Constituents, 2012

Parameter	Limit[a]	800171	800181	800191	800201	800271[b]	800281	800291	800301
Field Parameters									
Conductivity (µS/cm)	703	**955**	**996**	**1,468**	**1,187**	629	**1,130**	**1,207**	**1,037**
pH	6.57–7.88	**6.44**-6.85	7.39-7.80	**6.39**-6.77	6.85-6.92	6.96-7.27	**6.55**-6.82	6.88-6.98	6.74-6.92
Filtered Samples (mg/L)[c]									
Ammonia Nitrogen	0.9	0.06	0.19	0.16	**4.93**	< 0.05	< 0.05	< 0.05	0.08
Chloride	20	10	14	**71**	20	4	**56**	11	8
Sulfate	58	**64**	**99**	**301**	**83**	28	**108**	**171**	**155**
TDS	428	**474**	**544**	**992**	**652**	257	**615**	**612**	**583**
Arsenic	0.01	< 0.003	0.004	< 0.003	0.007	< 0.003	< 0.003	< 0.003	< 0.003
Iron	0.099	< 0.021	< 0.021	**0.24**	**3.93**	< 0.021	< 0.021	0.048	**0.42**
Manganese	0.097	< 0.01	0.05	**0.61**	**0.23**	< 0.01	**0.05**	0.05	**0.13**
Unfiltered Samples (mg/L)[c]									
Fluoride	4.0	< 0.01	0.34	0.32	0.12	0.21	< 0.01	0.44	< 0.01
Nitrate	10.0	0.50	< 0.10	< 0.10	0.42	0.64	< 0.10	< 0.10	< 0.10
Phenols (total)	0.033	<0.005	<0.005	<0.005	0.0052	<0.005	<0.005	<0.005	<0.005
TOCs	2.7	2.0	2.4	**4.6**	**31**	1.9	2.5	2.2	1.4
TOXs	0.086	0.022	0.028	0.034	0.027	< 0.020	0.059	0.031	< 0.020
Arsenic	0.05	< 0.003	0.003	< 0.003	0.010	< 0.003	< 0.003	< 0.003	< 0.003
Barium	2.0	0.054	0.054	0.059	0.280	0.014	0.054	0.019	0.020
Boron	2.0	0.12	< 0.1	< 0.1	< 0.1	< 0.1	0.18	< 0.1	< 0.1
Iron	5.0	0.16	< 0.021	0.31	5.8	< 0.021	< 0.021	0.048	0.66
Manganese	0.15	< 0.01	0.014	**0.67**	**0.23**	< 0.01	< 0.01	0.020	0.070
Hydrogen-3 (pCi/L)	20,000	< 100	< 100	< 100	< 100	< 100	< 100	< 100	< 100

[a] Refer to Table 6.9 for an explanation of groundwater quality limits for the 800 Area landfill.

[b] Background well.

[c] In addition to the parameters shown, these samples were also analyzed for cadmium, chromium, cobalt, copper, lead, mercury, nickel, selenium, silver, zinc, and cyanide, but none of the samples contained these compounds above their detection limits.

TABLE 6.11 (Cont.)

Annual Average Concentrations of 800 Area Landfill Shallow Groundwater Constituents, 2012

Parameter	Limit[a]	800321	800331	800341	800351	800361	800371	800381
Field Parameters								
Conductivity (µS/cm)	703	**2,325**	**861**	**1,012**	**933**	**886**	**971**	**1,596**
pH	6.57–7.88	**6.36-**6.70	6.88-7.23	7.09-7.22	6.82-7.01	6.79-7.24	6.70-7.30	6.62-6.74
Filtered Samples (mg/L)[b]								
Ammonia Nitrogen	0.9	0.36	0.78	< 0.05	0.22	< 0.05	0.66	0.07
Chloride	20	20	5	9	4	14	4	17
Sulfate	58	**1030**	**113**	**129**	57	**133**	**147**	**314**
TDS	428	**1960**	**434**	**493**	**450**	**446**	**512**	**954**
Arsenic	0.01	< 0.003	< 0.003	< 0.003	< 0.003	< 0.003	< 0.003	< 0.003
Iron	0.099	< 0.021	< 0.021	< 0.021	**0.81**	< 0.021	**0.18**	**0.59**
Manganese	0.097	**0.13**	0.05	< 0.01	0.02	0.02	**0.22**	**0.21**
Unfiltered Samples (mg/L)								
Fluoride	4.0	0.32	0.47	< 0.01	0.21	0.47	0.16	0.11
Nitrate	10.0	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Phenols (total)	0.033	0.011	< 0.005	< 0.005	0.021	< 0.005	0.0054	0.018
TOCs	2.7	1.9	1.3	1.9	1.7	1.9	1.4	**3.2**
TOXs	0.086	0.030	0.026	0.027	< 0.020	0.033	< 0.020	0.047
Arsenic	0.05	< 0.003	< 0.003	< 0.003	0.003	0.003	< 0.003	< 0.003
Barium	2.0	0.013	0.038	0.027	0.082	0.031	0.032	0.029
Boron	2.0	< 0.1	< 0.1	< 0.1	0.1	< 0.1	0.12	< 0.1
Iron	5.0	0.032	0.023	< 0.021	1.56	< 0.021	0.32	0.063
Manganese	0.15	0.020	< 0.01	< 0.01	0.020	0.030	0.19	0.25
Hydrogen-3 (pCi/L)	20,000	< 100	< 100	< 100	< 100	<100	< 100	<100

[a] Refer to Table 6.9 for an explanation of groundwater quality limits for the 800 Area landfill.

[b] In addition to the parameters shown, these samples were also analyzed for cadmium, chromium, cobalt, copper, lead, mercury, nickel, selenium, silver, zinc, and cyanide, but none of the samples contained these compounds above their detection limits.

dissolved inorganic matter (expressed by conductivity, total dissolved solids, sulfate, and chloride concentrations) higher than the background values. These elevated parameters are thought to result from the proximity of the downgradient wells to roadways and parking areas that are salted in the winter. It is thought that the salt in road runoff has migrated to the shallow wells, increasing the concentration of salts in the groundwater which results in elevated readings for these parameters. The background well is far from roadways or paved areas and no roadway runoff passes near these wells; thus, these parameters are much lower than the wells near developed areas around the landfill.

In addition to the dissolved salts, several naturally occurring metals were found to be present above the background levels. Iron and manganese were found to be higher than background values in about half of the wells. These elevated levels are thought to result from the natural variation in soil composition around the landfill as well as from the influence of the nearby wetland area, immediately west of the landfill. The organic matter in the wetland soil generates acidic water which can solubilize naturally occurring metals, increasing their concentration in groundwater. Most of the wells with elevated levels of metals are adjacent to or near this wetland area. Two of these wells exceeded Class I groundwater quality standards for manganese. These two wells also exhibited higher than the background level of total organic carbon (TOC), and one of these wells was also elevated in ammonia, which may also be related to the presence of the wetland.

Three wells exhibited pH values that were slightly lower than the lower range of background values for pH. This is thought to result from natural variation in soil composition. None of the wells contained measureable amounts of hydrogen-3 during 2012.

There is no evidence of the release of toxic chemicals or radioactive materials from the landfill. The parameters that are elevated are likely not related to releases from the landfill, but are caused by natural or unrelated man-made factors such as roadway runoff.

6.5.4. Discussion of Results — Bedrock Monitoring Wells

The average 2012 results for the deep wells are shown in Table 6.12. No VOCs, SVOCs, PCB/pesticides were found in any of the samples. Ten metals in addition to those shown were analyzed but none was detected. These results are not shown for clarity.

The amount of dissolved salts in the deep wells was much lower than that in the shallow wells. The lower dissolved salt concentrations may be a result of the greater depth of these wells, which reduces the impact of salts in road runoff. Only one well, 800193D, contained conductivity, chloride, and TDS values above the background limit. This well is immediately adjacent to the wetland. This well and two other nearby wells also had elevated ammonia levels.

TABLE 6.12

Annual Average Concentrations of 800 Area Landfill Dolomite Bedrock Groundwater Constituents, 2012

Parameter	Limit[a]	800383D	800173D	800183D	800193D	800203D	800273D[b]
Field Parameters							
Conductivity (µS/cm)	1,306	1,240	1,079	1,210	**1,531**	1,277	1,005
pH	6.48–7.74	6.81-7.07	6.94-7.15	6.82-7.07	6.96-7.02	6.63-6.99	6.71-7.18
Filtered Samples (mg/L)[c]							
Ammonia Nitrogen	1	0.90	0.98	**1.41**	**1.32**	**2.73**	0.94
Chloride	140	118	91	132	**270**	127	66
Sulfate	150	121	111	121	100	48	96
TDS	880	721	602	776	**973**	660	535
Arsenic	0.0048	0.0040	0.0035	< 0.003	0.0040	**0.0053**	**0.0050**
Iron	1.6	1.095	1.185	0.813	1.430	**1.688**	1.265
Manganese	0.021	**0.038**	**0.033**	<0.01	**0.033**	**0.025**	<0.01
Unfiltered Samples (mg/L)[c]							
Fluoride	4	0.34	<0.01	0.57	0.23	<0.01	0.40
Nitrate	10	< 0.10	0.19	< 0.10	0.15	0.80	< 0.10
Phenols (total)	0.033	< 0.0050	< 0.0050	< 0.0050	0.033	0.0064	< 0.0050
TOCs	5.3	2.0	1.7	2.4	3.5	4.8	1.5
TOXs	0.041	0.040	**0.043**	**0.060**	**0.057**	**0.056**	**0.042**
Arsenic	0.05	<0.003	0.004	<0.003	0.003	0.008	0.006
Barium	2	0.060	0.065	0.043	0.074	0.130	0.050
Boron	2	0.17	0.17	0.18	0.16	0.16	0.17
Iron	5	1.46	2.12	0.93	1.84	2.52	1.47
Manganese	0.15	0.040	0.030	<0.01	0.027	0.030	<0.01
Hydrogen-3 (pCi/L)	20,000	<100	<100	<100	<100	<100	<100

[a] Refer to Table 6.9 for an explanation of groundwater quality limits for the 800 Area landfill.

[b] Background well.

[c] In addition to the parameters shown, these samples were also analyzed for cadmium, chromium, cobalt, copper, lead, mercury, nickel, selenium, silver, zinc, and cyanide, but none of the samples contained these compounds above their detection limits.

Four of the wells had soluble manganese concentrations higher than background levels. Five wells, including the background well, exhibited low, but above-background levels, of TOX. No hydrogen-3 was detected in any of the deep wells. None of the 2012 results exceeded the Class I groundwater quality standards.

6.6. CP-5 Reactor Area Monitoring

In addition to the required sampling of former waste sites, Argonne is voluntarily monitoring the condition of groundwater near the site of the former CP-5 reactor. The CP-5 reactor was a five megawatt research reactor that was used from 1954 until operations ceased in 1979. Decontamination of the interior of the structure, an investigation of the area surrounding the reactor, and corrective actions were completed by 2002. The IEPA issued a notice of NFA in 2003. In 2011, the final decontamination and demolition of the CP-5 structure was completed with the removal of all of the reactor components that were above and below the ground.

Groundwater adjacent to the reactor complex has been monitored since 1989. Figure 6.13 shows the current monitoring well network. All wells are screened in the glacial drift. The current network of wells is sampled quarterly and analyzed for soluble metals, chloride (filtered samples), and radioactive materials (cesium-137, hydrogen-3, and strontium-90). The results are presented in Table 6.13. The results are compared to Class I GQS and any results above these limits are shown in bold.

Elevated chloride levels were found in three wells. The two wells with the highest chloride results are located near the current road salt storage facility (a steel dome that had been part of the reactor complex but was converted to salt storage). Salt-laden runoff from this area is thought to be migrating to the wells, increasing chloride levels. The third well is located near Rock road and runoff from this road is creating the elevated chloride levels.

Five of the six wells had at least one sample with soluble metals above analytical detection limits, but only manganese and nickel were detected in concentrations above GQS. It is thought that these metals are of natural origin. There are no known man-made sources of these metals near the CP-5 reactor.

Hydrogen-3 was detected during at least one quarter in four of the six wells, but only one exceeded the GQS of 20,000 pCi/L. Well 330031R had an average concentration of 24,863 pCi/L. This well is located near the former reactor's sewer line. It is thought that contaminated wastewater released into the sewer system during its operational lifetime leaked out into the soil surrounding the sewer. Well 330031R (a replacement well) happened to encounter a region of soil containing some of this contaminated wastewater. An investigation performed in 2006 confirmed that the hydrogen-3 is isolated in a small porous zone and there is little migration of groundwater away from the reactor. Strontium-90 was detected in two wells at concentrations just above detection limits. All of the strontium-90 results were below the GQS of 8 pCi/L. Cesium 137 was not found above the analytical detection limit of 2 pCi/L in any of the wells.

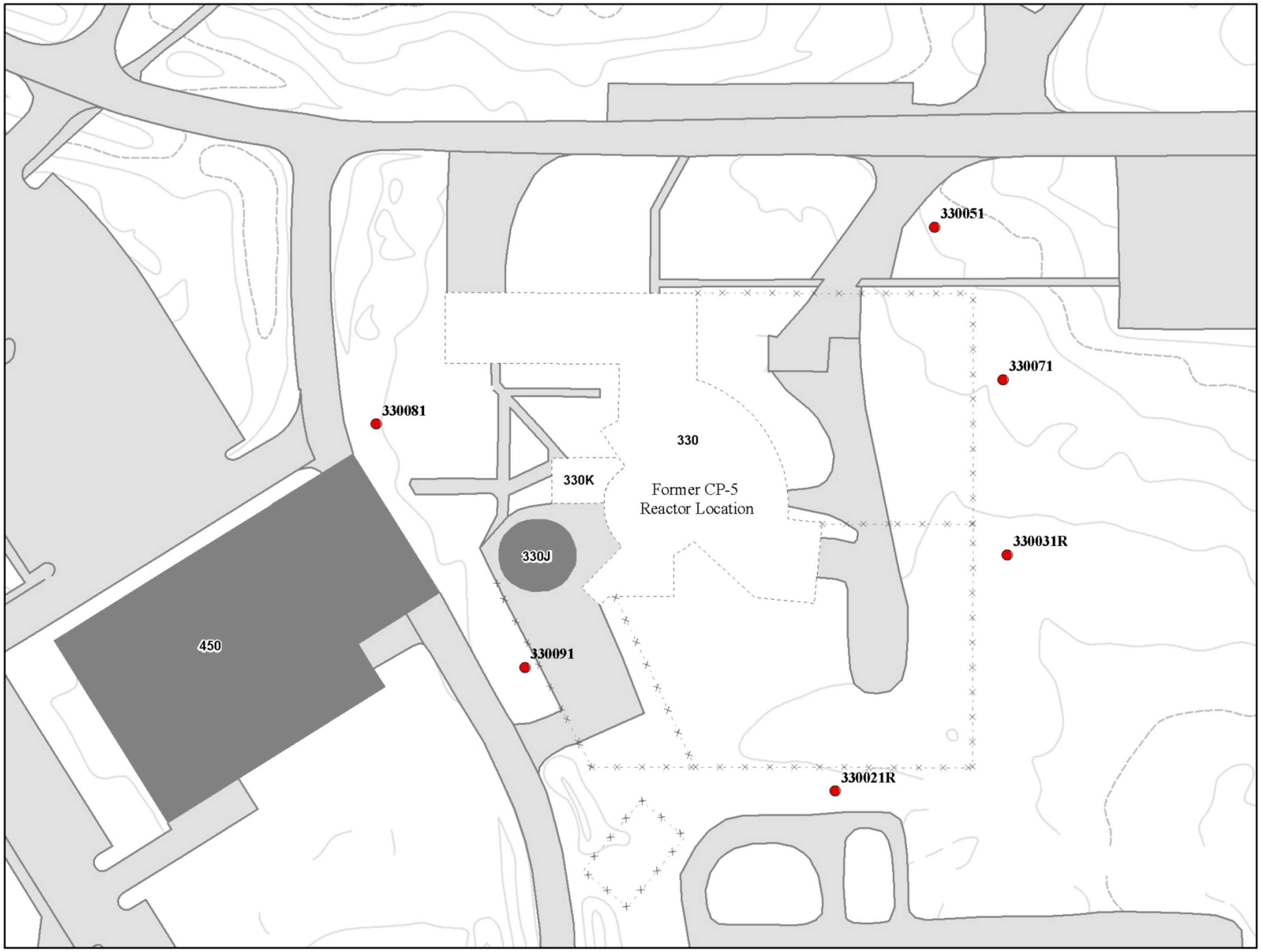


FIGURE 6.13 Monitoring Wells in the CP-5 Reactor Area

TABLE 6.13

Annual Average Concentrations of CP-5 Groundwater Constituents, 2012

Parameter	Standards	Well Number 330021R	330031R	330051	330071	330081	330091
Inorganics (mg/L)							
Chloride	200	146	133	**327**[a]	11	**905**	**5,041**
Filtered Metals (mg/L)							
Arsenic	0.05	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
Barium	2	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Beryllium	0.004	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	0.0026
Cadmium	0.005	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025
Chromium	0.1	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Cobalt	1	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25
Copper	0.65	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
Iron	5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Lead	0.0075	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
Manganese	0.15	<0.075	**0.33**	0.095	**0.30**	0.10	**2.25**
Mercury	0.002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Nickel	0.1	<0.05	<0.05	0.095	<0.05	**0.16**	<0.05
Silver	0.05	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025
Thallium	0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Vanadium	NA	<0.075	<0.075	<0.075	<0.075	<0.075	<0.075
Zinc	5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Radionuclides (pCi/L)							
Cesium-137	NA	<2	<2	<2	<2	<2	<2
Hydrogen-3	20,000	209	**24,863**	<100	210	<100	666
Strontium-90	8	<0.25	<0.25	<0.25	<0.25	0.27	0.30

[a] Bold font indicates results above the Class I GQS limit.

6.7. Monitoring Former Potable Water Supply Wells

Until 1997, domestic water was supplied by four potable water supply wells that were drilled approximately 100 m (328 ft) deep into the dolomite bedrock. The well locations are shown in Figure 1.1. Use of these wells was discontinued when the source of Argonne's water supply was changed to Lake Michigan water, obtained from the DuPage Water Commission. The pumps in Wells 1, 2, and 4 are no longer operational. Well 3 is operational and is maintained as a backup water source in case of a loss of Lake Michigan water.

Well 3 was sampled quarterly in 2012. The existing pump was used to purge the well of stagnant water, after which a sample of the pump discharge was collected. The samples were analyzed for total alpha and beta radioactivity, hydrogen-3, strontium-90, and VOCs.

The radiological results are summarized in Table 6.14. No VOCs were detected above the detection limit in any of the samples; for clarity, these VOC results are not shown. The detection limits for VOCs were 1 to 10 μg/L. All results were consistent with normal background levels.

6.8. Monitoring of an Artesian Well

An artesian well is located about 2,000 m (6,000 ft) southwest of the 317 Area in the Waterfall Glen Forest Preserve (grid location 3E in Figure 1.1). The water from this well is sampled quarterly and analyzed for hydrogen-3. All hydrogen-3 concentrations in 2012 were below the detection limit of 100 pCi/L.

6.9. Groundwater Monitoring Program Summary

Argonne groundwater sampling activities during 2012 are summarized in Table 6.15. The monitoring program is a critical element of Argonne's groundwater protection program. The groundwater monitoring strategy focuses resources on those areas that have the potential to impact groundwater. The analytical results generated by the monitoring program demonstrate the degree of compliance with applicable groundwater standards and limits and they identify the need for groundwater remediation. Overall, groundwater quality at Argonne is good, with significant contamination present at only one location, the 317/319 Area, where concentrations of VOCs in groundwater are above applicable standards. Some of this groundwater comes to the surface in several small groundwater seeps in an isolated part of the Waterfall Glen Forest Preserve. Several remedial actions are underway in this area to reduce contaminant levels, including two groundwater extraction systems, an impermeable cap over the 319 landfill, and a phytoremediation system. Groundwater under the 800 Area Landfill exhibits elevated levels of a

TABLE 6.14

Radioactivity in Argonne Former Water Supply Well No. 3, 2012

Parameter[a] (pCi/L)	Sample Date			
	March 19	June 13	September 17	December 10
Alpha	1.7	4.5	3.4	1.8
Beta	9.3	9.3	8.1	9.3
Hydrogen-3	< 100	< 100	< 100	< 100
Strontium-90	< 0.25	< 0.25	< 0.25	< 0.25

[a] In addition to the parameters shown, these samples were also analyzed for VOCs. None was detected.

TABLE 6.15

Summary of Groundwater Monitoring by Area, 2012

Groundwater Monitoring Element	Purpose	Number of Wells in Network	Number of Wells Sampled	Number of Sampling Events	Number of Analyses Performed	Percent of Results Nondetectable
Former water supply wells	Environmental Surveillance	4	1	4	252	97%
317/319 Area wells and manholes	Environmental Surveillance	13	13	62	5.825	92%
317/319/ENE and GMZ wells and seeps	Permit Compliance/ LTS Program	71	44	152	7,450	86%
800 Area Landfill wells	Permit Compliance	24	21	84	9,123	88%
CP-5 wells	Environmental Surveillance	6	6	23	460	87%

number of naturally-occurring metals and inorganic constituents; however, they are probably not related to landfill operations. Elevated levels of hydrogen-3 have been found in one well adjacent to the CP-5 reactor; however, hydrogeological studies have determined that this water is not migrating away from the reactor, and it does not represent a hazard. There is little evidence of contamination in the dolomite aquifer, which is the uppermost usable aquifer under the site. Only one dolomite well in the 317 Area contains man-made contamination above applicable limits.

As shown in Table 6.15, the vast majority of the analytical results in 2012 were below detection limits. Of the results above detection limits, only a small fraction are above applicable standards for chemicals or radioactive materials.

7. QUALITY ASSURANCE

Quality assurance is an integral part of every activity at Argonne National Laboratory (Argonne). A comprehensive Quality Assurance/Quality Control (QA/QC) program is in place to ensure that all environmental monitoring samples are representative and all associated data are reliable. The environmental samples are collected by Argonne personnel. About 95% of the samples are analyzed by Argonne personnel in an in-house analytical laboratory. The remaining samples are sent to various contracted laboratories for analysis. Quality Control is maintained through instrument checks; processing blanks, spikes, and duplicates; and processing intercomparison samples. Results are reviewed and verified before being used to support decision making.

Quality Assurance is maintained through data quality objectives, internal audits, quality assurance plans, operating manuals, sampling plans, and procurement contracts. Quality Assurance plans and associated documents exist for both radiological and nonradiological analyses. These documents were prepared in accordance with DOE Order 414.1D.[28] The *Uniform Federal Policy (UFP) for Implementing Environmental Quality Systems* (March 2005) and the associated draft *Uniform Federal Policy for Quality Assurance Project Plans* (March 2005) documents have been used as guidance in the quality assurance programs.

7.1. Sample Collection

Environmental monitoring samples (soils, waters, and air filters) were collected as specified in various documents, including standard operating procedures, Quality Assurance plans, Argonne's Environmental Monitoring Plan,[30] Argonne's Groundwater Protection Management Program Plan,[25] and various Argonne permits. Representative sampling is of prime importance. Samples are collected and stored in a manner that is designed to maintain the integrity of the analytical constituents. For example, samples for trace radionuclide analyses are acidified immediately after collection to prevent hydrolytic loss of metal ions and they are filtered to reduce leaching from suspended solids.

A weekly sample collection schedule is processed using a computer database system. This same computer system is used to track all pertinent information regarding the sample collection, all requested analyses, and the analytical results. Sample log-in information is transferred to the in-house analytical laboratory, along with a chain-of-custody transfer document. After the samples have been analyzed, resultant data is electronically transferred to the same computer system. Multi-level reviews are performed to validate sampling schedules, sample collection information, and the resultant data.

7.2. Radiochemical Analysis

All radiological analyses are performed by the in-house analytical laboratory. Details about the radiological analyses are maintained in the in-house laboratory standard operating procedure manual. Standard sources obtained from or traceable to the National Institute of Standards and Technology (NIST) are used to calibrate instrumentation for efficiency. Secondary counting standards are used to check proper instrument response. All results recorded by the in-house laboratory contain an activity level and a total propagated uncertainty, regardless of detection limits. Non-detects are reported as “less than” (<) the detection limit found in this annual report. A nuclide is considered as not detected if the activity level is below the analytical method detection limit. Detection limits are chosen so the measurement uncertainty at the 95% confidence level is equal to the measured value. Detection limits for air and water are listed in Table 7.1.

TABLE 7.1

Air and Water Detection Limits

Parameter	Air (fCi/m^3)	Water (pCi/L)
Americium-241	–[a]	0.001
Beryllium-7	5	–
Californium-249	–	0.001
Californium-252	–	0.001
Cesium-137	0.1	2
Curium-242	–	0.001
Curium-244	–	0.001
Hydrogen-3	–	100
Lead-210	1	–
Neptunium-237	–	0.001
Plutonium-238	–	0.001
Plutonium-239	–	0.001
Strontium-90	0.01	0.25
Uranium-234	–	0.01
Uranium-235	–	0.01
Uranium-238	–	0.01
Alpha	0.2	0.2
Beta	0.5	1

[a] A dash indicates that a value is not required.

Relative error in a result decreases with increasing concentration. At a concentration equal to twice the detection limit, the error is approximately 50% of the measured value; at 10 times the detection limit, the error is approximately 10% of the measured value. Radiological activity levels are measured by observing radionuclide decay. For radionuclides with few decays over time (e.g., long half-lives), the number of decay observations can be small. This can make the relative error in a result as important as the result itself.

Within this annual report, average values at a given location are accompanied by a plus-or-minus (±) limit value. Unless otherwise stated, this value is the standard error at the 95% confidence level calculated from the standard deviation of the average. The ± limit value is a measure of the range in the concentrations encountered at that location. This value does not represent the conventional uncertainty in the average of repeated measurements on the same or identical samples. Many of the variations observed in environmental radioactivity are not random, but occur for specific reasons (e.g., seasonal variations). Samples collected from the same location at different times are not replicates. The more random the variation in activity at a particular location, the closer the confidence limits will represent the actual distribution of values at that location. The averages and confidence limits should be interpreted with this in mind.

7.3. Chemical Analysis

Most non-radiological chemical analyses are performed by the in-house analytical laboratory. Approximately 5% of non-radiological analyses are performed by a contracted analytical laboratory. Chemical analyses details are maintained in the standard operating procedure manuals of the individual analytical laboratories. Contract laboratories are subject to the procurement technical specifications defined by Argonne, in addition to reviews conducted by Argonne employees.

Standard reference materials that are traceable to NIST are utilized to ensure the accuracy of most inorganic analyses, and they are replaced annually. Detection limits for metal analyses are listed in Table 7.2. In general, the detection limit is the measure of the variability of a standard material measurement at 5 to 10 times the instrument detection limit over an extended time period. Recovery of inorganic metals, as determined by "spiking" unknown solutions, must be within the range of 80 to 120%. The precision, as determined by analysis of duplicate samples, must be within 20%. These measurements must be taken for at least 10% of the samples. Standards certified by the American Association for Laboratory Accreditation (A2LA) are utilized to ensure the accuracy of most organic analyses. At least one standard mixture is analyzed each month. Quantification limits vary with the analytical method and are listed within the appropriate standard operating procedure.

TABLE 7.2

Metals Detection Limits, 2012

Parameter	AA[a] (mg/L)	ICP[b] (mg/L)
Antimony	0.003	NA[c]
Arsenic	0.003	0.025
Barium	NA	0.012
Beryllium	0.0025	0.0025
Boron	NA	0.10
Cadmium	0.0025	0.0025
Chromium	NA	0.05
Cobalt	NA	0.25
Copper	NA	0.025
Iron	NA	0.021
Lead	0.004	0.09
Manganese	NA	0.010
Mercury	0.0002	NA
Nickel	NA	0.05
Selenium	0.003	NA
Silver	0.001	0.0025
Thallium	0.002	NA
Vanadium	NA	0.075
Zinc	NA	0.02

[a] AA = atomic absorption spectroscopy

[b] ICP = inductively coupled plasma-optical emission spectroscopy

[c] NA = not analyzed

7.4. Demonstration of Proficiency

In 2012, Argonne participated in two environmental proficiency testing programs: the Mixed Analyte Performance Evaluation Program (MAPEP) administered by the Radiological and Environmental Sciences Laboratory (RESL), and the Discharge Monitoring Report-Quality Assurance Program (DMR-QA) administered by the EPA. Proficiency testing programs involve an accredited proficiency test provider sending a series of intercomparison samples to Argonne. Argonne analyzes the samples and submits the analytical results to the provider. The laboratory's proficiency is determined by comparing the analytical results with the provider's reference values. Argonne has consistently performed very well on these tests.

The MAPEP program consists of a semiannual distribution of sample matrices containing combinations of radionuclides. The results are provided in Tables 7.3 and 7.4. The 2012 Argonne performance resulted in 96% (48 out of 50) of the analyses being in the MAPEP acceptable range. The remaining two out of 50 values were within the 'Acceptable With Warning' range. The DMR-QA program consists of an annual distribution of sample proficiency testing standards containing combinations of non-radiological components. The results are provided in Table 7.5. Argonne's performance resulted in 89% (32 out of 36) of the analyses being in the DMR-QA acceptable range. The "not acceptable" results for mercury and chloride were investigated, followed by corrective action statements issued. Graded results for biochemical oxygen demand and ammonia nitrogen were not received from the contract laboratory, thus warranting "not acceptable" evaluations.

TABLE 7.3

Summary of MAPEP Series 26 Intercomparison Sample Results, April 2012

Analyte	Matrix	Units	Reported Value	Reference Value	Acceptance Range	Performance Evaluation
Am-241	air filter	Bq/filter	0.071	0.073	0.051–0.095	Acceptable
Cs-134	air filter	Bq/filter	1.72	2.38	1.67–3.09	Acceptable With Warning
Cs-137	air filter	Bq/filter	1.62	1.79	1.25–2.33	Acceptable
Co-57	air filter	Bq/filter	0.02	-[a]	False Positive Test	Acceptable
Co-60	air filter	Bq/filter	2.11	2.182	1.527–2.837	Acceptable
Mn-54	air filter	Bq/filter	3.20	3.24	2.27–4.21	Acceptable
Pu-238	air filter	Bq/filter	0.003	0.0015	Sensitivity Evaluation	Acceptable
Pu-239/240	air filter	Bq/filter	0.101	0.097	0.068–0.126	Acceptable
Sr-90	air filter	Bq/filter	0.003	-	False Positive Test	Acceptable
U-234/233	air filter	Bq/filter	0.019	0.0188	0.0132–0.0244	Acceptable
U-238	air filter	Bq/filter	0.118	0.124	0.087–0.161	Acceptable
Zn-65	air filter	Bq/filter	2.92	2.99	2.09–3.89	Acceptable
Am-241	water	Bq/L	1.46	1.63	1.14–2.12	Acceptable
Cs-134	water	Bq/L	-0.06	-	False Positive Test	Acceptable
Cs-137	water	Bq/L	40.29	39.9	27.9–51.9	Acceptable
Co-57	water	Bq/L	33.23	32.9	23.0–42.8	Acceptable
Co-60	water	Bq/L	25.0	23.72	16.60–30.84	Acceptable
H-3	water	Bq/L	438.91	437	306–568	Acceptable
Mn-54	water	Bq/L	31.65	31.8	22.3–41.3	Acceptable
Pu-238	water	Bq/L	0.595	0.629	0.440–0.818	Acceptable
Pu-239/240	water	Bq/L	1.25	1.34	0.94–1.74	Acceptable
Sr-90	water	Bq/L	0.02	-	False Positive Test	Acceptable
U-234/233	water	Bq/L	0.36	0.392	0.274–0.510	Acceptable
U-238	water	Bq/L	2.45	2.76	1.93–3.59	Acceptable
Zn-65	water	Bq/L	-0.65	-	False Positive Test	Acceptable

[a] A dash indicates no reference value is needed.

TABLE 7.4

Summary of MAPEP Series 27 Intercomparison Sample Results, October 2012

Analyte	Matrix	Units	Reported Value	Reference Value	Acceptance Range	Performance Evaluation
Am-241	air filter	Bq/filter	0.074	0.0780	0.0546–0.1014	Acceptable
Cs-134	air filter	Bq/filter	2.21	2.74	1.92–3.56	Acceptable
Cs-137	air filter	Bq/filter	0.05	–[a]	False Positive Test	Acceptable
Co-57	air filter	Bq/filter	1.85	1.91	1.34–2.48	Acceptable
Co-60	air filter	Bq/filter	1.83	1.728	1.210–2.246	Acceptable
Mn-54	air filter	Bq/filter	2.31	2.36	1.65–3.07	Acceptable
Pu-238	air filter	Bq/filter	0.057	0.0625	0.0438–0.0813	Acceptable
Pu-239/240	air filter	Bq/filter	0.005	0.00081	Sensitivity Evaluation	Acceptable
Sr-90	air filter	Bq/filter	1.020	1.03	0.72–1.34	Acceptable
U-234/233	air filter	Bq/filter	0.016	0.0141	0.0099–0.0183	Acceptable
U-238	air filter	Bq/filter	0.082	0.100	0.070–0.130	Acceptable
Zn-65	air filter	Bq/filter	-0.41	–	False Positive Test	Acceptable
Am-241	water	Bq/L	0.95	1.06	0.74–1.38	Acceptable
Cs-134	water	Bq/L	18.35	23.2	16.2–30.2	Acceptable With Warning
Cs-137	water	Bq/L	17.05	16.7	11.7–21.7	Acceptable
Co-57	water	Bq/L	29.41	29.3	20.5–38.1	Acceptable
Co-60	water	Bq/L	0.17	–	False Positive Test	Acceptable
H-3	water	Bq/L	333.42	334	234–434	Acceptable
Mn-54	water	Bq/L	16.94	17.8	12.5–23.1	Acceptable
Pu-238	water	Bq/L	0.018	0.013	Sensitivity Evaluation	Acceptable
Pu-239/240	water	Bq/L	1.556	1.61	1.13–2.09	Acceptable
Sr-90	water	Bq/L	11.82	12.2	8.5–15.9	Acceptable
U-234/233	water	Bq/L	0.40	0.451	0.316–0.586	Acceptable
U-238	water	Bq/L	2.79	3.33	2.33–4.33	Acceptable
Zn-65	water	Bq/L	22.61	25.9	18.1–33.7	Acceptable

[a] A dash indicates no reference value is needed.

TABLE 7.5

Summary of DMR-QA Study 32 Intercomparison Samples Results, 2012

Analyte	Units	Reported Value	Assigned Value	Acceptance Limits	Performance Evaluation
Antimony	ug/L	511	503	351–606	Acceptable
Arsenic	ug/L	654	656	551–768	Acceptable
Barium	ug/L	837	875	759–987	Acceptable
Beryllium	ug/L	722	741	631–837	Acceptable
Boron	ug/L	1016	1030	849–1200	Acceptable
Cadmium	ug/L	216	226	192–257	Acceptable
Chromium	ug/L	512	522	454–591	Acceptable
Cobalt	ug/L	355	356	312–399	Acceptable
Copper	ug/L	785	812	731–893	Acceptable
Iron	ug/L	393	406	356–463	Acceptable
Lead	ug/L	306	320	276–363	Acceptable
Manganese	ug/L	1315	1320	1190–1470	Acceptable
Mercury	ug/L	7.38	14.0	8.62–18.9	Not Acceptable
Mercury (Low-Level)[a,b]	ng/L	37.2	36.4	23.8–48.7	Acceptable
Nickel	ug/L	916	949	854–1060	Acceptable
Selenium	ug/L	395	375	295–435	Acceptable
Silver	ug/L	205	201	172–230	Acceptable
Thallium	ug/L	812	784	646–931	Acceptable
Vanadium	ug/L	925	974	854–1090	Acceptable
Zinc	ug/L	362	366	313–424	Acceptable
Chloride	mg/L	98	84.4	72.3–96.6	Not Acceptable
Fluoride	mg/L	2.45	2.15	1.76–2.55	Acceptable
Sulfate	mg/L	34	35.8	28.9–41.8	Acceptable
Phosphorus	mg/L	2.23	2.13	1.72–2.56	Acceptable
Biochemical Oxygen Demand[a]	mg/L	–[d]	–[d]	–[d]	Not Acceptable
Chemical Oxygen Demand	mg/L	126	147	112–168	Acceptable
Ammonia Nitrogen[a]	mg/L	–[d]	–[d]	–[d]	Not Acceptable
Total Residual Chlorine (Low-Level)	ug/L	150	154	94.0–214	Acceptable
Total Cyanide[a,c]	mg/L	0.305	0.293	0.145–0.447	Acceptable
pH	S.U.	7.26	7.23	7.03–7.43	Acceptable
Total Phenolics[a,c]	mg/L	2.23	2.78	1.54–4.61	Acceptable
Total Suspended Solids	mg/L	62.0	65.1	52.1–73.3	Acceptable
Total Dissolved Solids	mg/L	414	358	271–445	Acceptable
Oil & Grease	mg/L	62.8	65.0	43.8–77.6	Acceptable
Fathead Minnow Acute Toxicity[a]	LC_{50}	16.5%	21	5.95–36.0	Acceptable
Ceriodaphnia dubia Acute Toxicity[a]	LC_{50}	82.8%	46.1	7.23–85.1	Acceptable

[a] Analysis performed by contract laboratory.

[b] In lieu of participation in DMR-QA Study 32, results of WP-207 Study were used.

[c] In lieu of participation in DMR-QA Study 32, results of WP-0112 Study were used.

[d] Graded results not received from contract laboratory.

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